NATIONAL LABORATORY RELATIONSHIPS WITH INDUSTRY AND THE UNIVERSITY COMMUNITY

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS

AND THE

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

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[1] On assignment to Budget Committee for 97th Congress.

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NATIONAL LABORATORY RELATIONSHIPS WITH INDUSTRY AND THE UNIVERSITY COMMUNITY

WEDNESDAY, JULY 29, 1981

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS, SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION,

Washington, D.C.

The subcommittees met, pursuant to notice, at 9:30 a.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the Subcommittee on Energy Development and Applications) presiding.

Mr. FUQUA. The subcommittees will be in order.

This morning the Subcommittee on Energy Development and Applications joins the Subcommittee on Energy Research and Production to hold a hearing on one of the country's major technical resources, namely, the Department of Energy's National Laboratory System.

This committee has had a longstanding interest in the national laboratories, their vitality, their productivity, their special role in energy research and development.

Today's hearing will focus on the relationship of the DOE laboratories with industry and the university community.

I am certain that most of our committee members recognize that the national labs play a unique and vital role in our overall energy program. They are performing essential research and development at the forefront of new technology, and their record of past accomplishments is outstanding. Some of the very best scientific talent and research facilities in the world are located at the DOE labs.

Nevertheless, there has been persistent criticism from several quarters that the labs enjoy a privileged status which perhaps unfairly limits the allocation of Federal research and development funds for private industry and the universities and, further, that the labs need more effective programs for the rapid transfer of promising technology into the private sector.

I would mention that just 2 weeks ago our Subcommittee on Science, Research and Technology held 3 days of hearings on the general issue of technology transfer in connection with the implementation of Public Law 96-480, the Stevenson-Wydler Technology Innovation Act of 1980. So technology transfer is a subject of considerable importance to the entire committee.

Furthermore, given the administration's stated policy of allowing the marketplace to select energy technologies for commercialization, we want to learn what approaches might increase the exchange of personnel and technical knowledge between the laborato-

ries and the private sector. It may be useful to compare the current Department of Energy laboratory practices with those of other Federal agencies, notably the National Aeronautics and Space Administration and the Department of Defense.

We are also eager to learn about the general health and well-being of the labs, particularly in light of the stringent fiscal year 1982 Federal budget.

To help us explore these timely issues, we have a panel of truly distinguished and informed witnesses. We are delighted to welcome Dr. George Keyworth, the President's Science Adviser, to his first formal appearance at the House of Representatives, and I'm sure it will be the first of many.

Dr. Keyworth comes to his new post after serving ably on the research staff of DOE's Los Alamos National Scientific Laboratory.

We are also pleased to have with us Dr. Allan Bromley of Yale University, who is currently president of the American Association for the Advancement of Science, an organization with which our committee has always worked cordially on matters of mutual interest. Dr. Bromley, it should be noted, serves on the Board of Directors of one or more of the DOE national labs.

We also welcome Dr. Arthur Bueche, the vice president of Corporate Technology at General Electric Co. Dr. Bueche, besides being responsible for a large research and development enterprise in the private sector, is a former member of President Reagan's Transition Team on Science and Technology, so he is also in a very excellent position to address the issues that concern us today.

We are also pleased to have with us Dr. Walter Massey, the Director of the Argonne National Laboratory, one of DOE's major multiprogram facilities. Dr. Massey has a distinguished career in physics and science education and currently serves on the board of directors of the American Association for the Advancement of Science and the prestigious National Science Board.

Gentlemen, we are indeed privileged to have all of you with us today, and we look forward to hearing your testimony.

Before I would begin, I would like to ask unanimous consent to insert some remarks by Mr. Winn and Mr. Lujan following my remarks, and I'd be happy to now recognize Mrs. Bouquard, who is the chairman of the Subcommittee on Energy Research and Production.

[The opening statements of Mr. Winn and Mr. Lujan follows:]

OPENING STATEMENT
THE HONORABLE LARRY WINN, JR.
HEARING ON NATIONAL LABS RELATIONSHIPS
WITH INDUSTRY AND UNIVERSITIES
JULY 29, 1981

MR. CHAIRMAN, THE NATION'S SCIENTIFIC COMMUNITY IS WELL REPRESENTED AT OUR HEARING TODAY. THE PRESIDENT'S SCIENCE ADVISOR, RECENTLY APPOINTED, AND HAVING NATIONAL LABORATORY BACKGROUND, IS WITH US. THE CURRENT HEAD OF THE AMERICAN ACADEMY FOR THE ADVANCEMENT OF SCIENCE AND PROFESSOR OF A PROMINENT UNIVERSITY WILL PROVIDE INSIGHT FROM THAT SECTOR. THE MAN RESPONSIBLE FOR RESEARCH AT ONE OF THE WORLD'S LEADING INDUSTRIAL COMPANIES WILL TESTIFY. AND THE DIRECTOR OF ONE OF OUR LARGE, WELL-KNOWN NATIONAL LABORATORIES WILL PRESENT ANOTHER VIEWPOINT IN THE APPORTIONMENT OF RESEARCH AND DEVELOPMENT RESOURCES.

THIS COMMITTEE HAS HEARD FROM OTHER EXPERTS ON THE RELATIONSHIP BETWEEN NATIONAL LABORATORIES, UNIVERSITIES, AND INDUSTRY. WE ARE AWARE OF THE LABORATORIES' FACILITIES, MANY OF WHICH WERE AUTHORIZED BY THIS COMMITTEE. WE AGREE THAT OUR SCIENTIFIC FUTURE EMANATES FROM OUR COLLEGES AND UNIVERSITIES AND THEY MUST BE INTELLIGENTLY NURTURED. WE FIRMLY BELIEVE THAT THE NATION'S MIGHT AND GROWTH IS GREATLY ATTRIBUTABLE TO INDUSTRY AND ITS PROFIT-MOTIVATED RESEARCH EFFORTS.

NOW WE WOULD APPRECIATE ADVICE ON HOW THE STRENGTHS OF THESE THREE ENTITIES CAN BEST BE UTILIZED TO THE BETTERMENT OF EACH AND TO THE RENEWED GROWTH OF OUR NATIONAL CAPABILITIES. SURELY WE CAN EXPECT THAT KIND OF GUIDANCE FROM OUR WITNESSES AND I AM CERTAIN THAT THEY ARE EQUAL TO THE CHALLENGES.

THANK YOU FOR BEING WITH US.

OPENING STATEMENT
THE HONORABLE MANUEL LUJAN, JR.
HEARING ON NATIONAL LABORATORY RELATIONSHIPS
WITH INDUSTRY AND UNIVERSITIES
JULY 29, 1981

THANK YOU, MR. CHAIRMAN. THE NATIONAL LABORATORIES ARE A VALUABLE NATIONAL ASSET. THEY OFFER US POOLS OF TALENT AND EXPERTISE TO ADDRESS THE LONG-RANGE, HIGH-RISK RESEARCH THAT INDUSTRY IS NORMALLY NOT INVOLVED IN. IN ADDITION THEY OFFER INNUMERABLE UNIQUE AND VALUABLE FACILITIES. THE QUESTION IS HOW TO MAKE BEST USE OF THESE BLESSINGS THAT ARE PAID FOR BY THE TAXPAYERS. IN ADDITION, THE QUESTION TODAY IS WHAT THE CONGRESS CAN DO TO HELP THE TECHNOLOGY TRANSFER PROCESS. MR. GOLDWATER AND I EACH HAVE 2 NATIONAL MULTI-PROGRAM LABORATORIES IN OUR STATES SO WE CAN FEEL ESPECIALLY EXPERIENCED WITH AND CONCERNED ABOUT THE ISSUES WE WILL BE DISCUSSING HERE TODAY. WE KNOW WELL THAT EACH SIDE: THE LABORATORIES, THE UNIVERSITIES, THE INDUSTRIES, THE DEPARTMENT OF ENERGY, OTHER GOVERNMENT AGENICES, THE CONGRESS, HAVE THEIR OWN PERSPECTIVE, AND THIS HEARING'S PURPOSE IS TO GAIN A BETTER UNDERSTANDING OF THESE PERSPECTIVES AND WHAT ARE THE PROBLEMS AND WHAT ARE SOME OF THE SOLUTIONS.

WE WILL BE DISUCSSING THE PROCESS OF TECHNOLOGY TRANSFER. THIS HAS SEVERAL ASPECTS. THE LABS SERVE AS A FOCAL POINT FEEDING HIGH TECHNOLOGY INFORMATION INTO THE UNIVERSITIES. THIS INFORMATION IS USED IN UPPER-LEVEL COURSES TO PRODUCE WELL-TRAINED, UP-TO-DATE STUDENTS. THIS FORM OF TECHNOLOGY TRANSFER

FROM THE LABORATORIES TO THE UNIVERSITIES IS VERY IMPORTANT. IT IS ALSO IMPORTANT FOR BRIGHT IDEAS FROM UNIVERSITIES TO GET INTO THE LABORATORIES.

FINALLY, IT IS IMPORTANT FOR INDUSTRY TO BE INVOLVED EARLY ON IN THE RESEARCH AND DEVELOPMENT PROCESS BECAUSE BOTH SIDES BENEFIT. THE LABORATORIES LEARN ABOUT THE REAL WORLD MARKET ENGINEERING PROBLEMS AND INDUSTRY IS UP-TO-DATE ON THE TECHNOLOGY DEVELOPMENT ASPECTS.

WE ARE NOT INTERESTED IN DISCUSSING PETTY JEALOUSIES. THE NATION HAS INVESTED A LOT OF MONEY, TALENT AND MATERIALS IN THESE LABORATORIES AND THEIR PROGRAMS. SO IT IS IN THE NATIONAL INTEREST THAT WE MAKE TECHNOLOGY TRANSFER WORTH THE INVESTMENT. FOR THESE REASONS, I AM VERY INTERESTED IN HEARING FROM OUR DISTINGUISHED WITNESSES TODAY.

THANK YOU, MR. CHAIRMAN, FOR CALLING THESE HEARINGS. I AM LOOKING FORWARD TO THE OPPORTUNITY TO HEAR THE TESTIMONY AND TO RECEIVE ANSWERS AND SUGGESTIONS ON SOME VERY IMPORTANT ISSUES.

Mrs. BOUQUARD. Thank you very much, Mr. Chairman.

We are revisiting a topic which our predecessor subcommittees reviewed 3 years ago. We've certainly seen progress in terms of the national laboratories' role in energy R. & D. since that time, but of course progress has not occurred at the pace which the committee expected.

Mr. Chairman, I ask unanimous consent that the remainder of my remarks be inserted in the record, because I do think we want to move on and hear from our panel of witnesses today.

Thank you very much.

Mr. FUQUA. Without objection, so ordered.

[Additional statement from Mrs. Bouquard follows:]

HON. MARILYN L. BOUQUARD
STATEMENT ON
DOE NATIONAL LABORATORIES HEARING
JULY 29, 1981

TODAY WE ARE REVISITING A TOPIC WHICH OUR PREDECESSOR SUB-COMMITTEES REVIEWED THREE YEARS AGO. WE HAVE SEEN PROGRESS IN TERMS OF THE NATIONAL LABORATORIES ROLE IN ENERGY R&D SINCE THAT TIME, BUT PROGRESS HAS NOT OCCURRED AT THE PACE THE COMMITTEE EXPECTED.

THE PREMISE OF THIS COMMITTEE IN ENCOURAGING THE NATIONAL LABORATORIES TO DO ENERGY R&D WAS THAT THEY CONSTITUTE A NATIONAL RESOURCE IN TERMS OF AVAILABLE EXPERTISE AND IN-PLACE FACILITIES. THE PROPER ROLE THAT WE PRESUMED FOR THESE LAB-ORATORIES WAS THE HISTORICAL ROLE OF FEDERAL LABORATORIES IN TECHNOLOGY DEVELOPMENT. I BELIEVE WE WOULD HAVE A GENERAL AGREEMENT HERE THIS MORNING ON THAT ROLE USING THE GENERAL CRITERION THAT IS IN THE NATIONAL INTEREST TO DO SO WHEN PRIVATE SECTOR INCENTIVES FOR R&D SIMPLY DO NOT EXIST. MANY MEMBERS BELIEVE THAT THE MARKETPLACE IS NOT THE ONLY DETER-MINING FACTOR FOR PERFORMING ENERGY R&D.

I BELIEVE THERE IS A HEALTHY DIFFERENCE IN OPINION THIS MORNING ON THE PRECISE EXTENT OF THE ROLE OF THE NATIONAL LABORATORIES ON THE PATHWAY TO THE MARKETPLACE AND I CER-TAINLY SHALL BE INTERESTED IN ARGUMENTS FROM BOTH SIDES ON THIS ISSUE.

I AM INCLINED TO AGREE WITH DR. BUECHE THAT TECHNOLOGY TRANSFER IS NOT VERY EFFICIENT. HOWEVER, I DON'T BELIEVE THE PRESUMPTION THAT INDUSTRY SHOULD SIMPLY RECEIVE FUNDING WITHOUT ANY DIRECTION IS THE MOST DESIRABLE APPROACH EITHER. WE ARE CERTAINLY INTERESTED IN A STRONG GOVERNMENT/INDUSTRY PARTNERSHIP WHERE TECHNOLOGY TRANSFER OCCURS NATURALLY.

ON THE OTHER HAND, OF COURSE, WE MUST RECOGNIZE THESE LABORATORIES CONSTITUTE A UNIQUE NATIONAL RESOURCE FOR THE FEDERAL GOVERNMENT IN (1) FOCUSING TECHNOLOGY DEVELOPMENT IN SOME ORDER OF NATIONAL PRIORITIES SO THAT GOVERNMENT AND BUSINESS RESOURCES CAN BE USED IN AN OPTIMUM FASHION, AND (2) SERVING AS A "COHERENT CORPORATE MEMORY" FOR HANDS-ON TECHNOLOGY IN APPROPRIATE R&D AREAS WHERE INDUSTRY IS NOT INVOLVED ON A CONTINUING BASIS BECAUSE OF RISK OR OTHER FACTORS.

MR. CHAIRMAN, I HOPE THE LABORATORIES WILL CONTINUE TO PLAY A KEY ROLE IN ENERGY R&D AND WE CAN ENCOURAGE AN IMPROVED PARTNERSHIP WITH INDUSTRY AND THE UNIVERSITIES. WE MUST RECOGNIZE THAT IN THIS TIGHTENING BUDGET CLIMATE IT WILL EVEN BE MORE CHALLENGING TO MAKE BEST USE OF OUR NATIONAL TALENT FOR ENCOURAGING TECHNOLOGY DEVELOPMENT IN THE CIVILIAN ENERGY SECTOR.

Mr. FUQUA. At this time, Dr. Keyworth, we would like to welcome you again and welcome your testimony, and furthermore say that we look forward to working with you in behalf of many, many mutual issues of common interest that we all share. We are very happy to have you before our subcommittees.

Dr. KEYWORTH. Thank you, Mr. Chairman.

STATEMENT OF DR. GEORGE A. KEYWORTH II, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

Dr. KEYWORTH. Madame Chairman, Mr. Chairman and members of the subcommittees, I am pleased to testify this morning on the subject of the Department of Energy National Laboratory Relationships with Industry and the University Community. This is an important matter, and one well worthy of consideration by your subcommittees.

For the discussion today, you have wisely selected witnesses representing different sectors: The Government, the national laboratories, industry, and the universities. Having recently come from a national laboratory myself and being now a Federal official, I might be said to have divided loyalties. Whether or not that is true, I believe that my many years at Los Alamos, in addition to having fostered a certain affection for such institutions, have also given me a detailed perspective on their activities, one that should be useful in discussions such as we are engaged in today.

This is a timely period to discuss the national laboratories. They are approaching their third generation. They were born in far different times, and were creations of those times. Each was set up and manned with a very specific purpose in mind. Particularly in the last decade, the labs' missions have tended to expand and diversify, becoming somewhat diffuse. That expansion and diversification was in many respects a natural consequence of the laboratories' successful performance of their original tasks.

But a concomitant consequence has been a certain dilution and weakening of purpose and mission. And there were times when certain labs seemed to be going somewhat afield of their original purposes, either to maintain their size and strength, or to respond to shifting policy direction from Washington.

At this point let me emphasize that these effects did not occur equally in all the labs. Rather, they have varied from lab to lab, just as the labs themselves vary. In speaking of national labs, we must remember that they are all different; different in original purpose, different in evolution, organization and methods of operation; and different in relations with outside communities, such as the universities and industry.

Nevertheless, missions have changed, and so have the needs of the country. Therefore, it is appropriate and timely to reexamine and reevaluate the labs in terms of their own best interests and those of the country. In particular, it is a critical time to redefine their missions. I believe the administration will be undertaking such a review of the labs with that important purpose in mind.

Let me suggest that one reason for taking a fresh look at the national labs has to do with the future of our scientific and engineering manpower resources. At this time, when we are addressing

the problems of science and engineering education, and the possibility of not having enough well-trained people in critical areas of defense, industry, and teaching in the years ahead, we must recognize that we do have a tremendous source of talent in the national laboratories. They provide a considerable fraction of the best scientific and engineering expertise in the country. So I think it is important that we examine how wisely we are using this resource and how we might better use it in the future.

Here again, the situation varies from lab to lab. Some labs are closely allied with university communities, or may even be considered integral parts of those communities. Others are rather distant from the universities and, so, do not have direct interaction with scientific and engineering education.

It is important now to take a fresh look at these relationships with an eye toward maximizing the labs' expertise and their contributions to fulfilling national education and training needs.

There are several ways of enhancing this synergy. One is simply to expand the conventional interchange and interaction of lab and university personnel; such things as faculty members spending time working at the labs or lab researchers lecturing at the universities.

Another way is to increase the access by university researchers to national lab equipment and instrumentation. Such cooperation is of particular importance because of the deterioration of research equipment on the campuses and of the growing size, complexity and, particularly, the cost, of these new tools of science.

We must recognize and emphasize that even above the effects of inflation, the cost of some equipment needed to conduct today's physics research has risen in excess of 200 percent. For this reason, much of the equipment needed to do much of today's frontier research simply is well beyond the means of any single university laboratory.

For example, it is one thing to build a small Van de Graaff accelerator at every university, but you are obviously not going to build a 1-TEV accelerator for hundreds of millions of dollars at every university. That's why we have Fermi Lab, a single-purpose laboratory that was built to satisfy a particular requirement.

I believe that national laboratories should be encouraged to increase the user service they currently provide. One way to do this is through strong, two-way interaction with universities. As I said previously, the labs could contribute more to the teaching mission of the universities, and they should be made increasingly open to collaboration with universities. To accomplish this, Federal agencies should be encouraged to support joint academic-laboratory collaboration.

But here, I believe, is a key point. If you make the laboratories become merely service centers, you will lose the best talent the labs possess, because the most creative scientists do not wish to operate and will not operate in a service mode.

If you try just to let the national laboratories use an academic interaction as justification for their own health, they will not be motivated to develop truly meaningful interactions. But one thing that scientists truly understand is collaboration.

Today, however, while the funding agencies will generally support a lab program or an academic researcher, it seems very hard to get real collaboration funded jointly. I think this problem is a key issue to be considered and resolved.

Another matter of importance is that of national lab-industry interaction. Such interactions work well in a few cases, but in far too few, considering the Nation's needs and the resources of the laboratories.

There is one cause of this limitation we might emphasize, one I think our friends in industry particularly view as a problem. Let me elaborate on this briefly and perhaps bluntly, as it is a matter we should air if we are going to resolve it.

By way of background, of the DOE's 57 Government-owned, contractor-operated plants and laboratories, 41 are R. & D. labs of widely varying size and complexity of purpose; and 12 of these are multiprogram, multidisciplinary laboratories devoted to basic and applied science and technology. The funding of these 12 labs, about $4 billion in fiscal year 1981, represents more than one-fourth of the Department of Energy's budget. These labs also represent about $25 billion worth of capital facilities and they employ over 50,000 people, more than one-half of whom are scientists and technicians.

I think we have to face the fact that while we all view this as a tremendous national asset and look with pride on what has been and is being accomplished, there is an industry view that sees it in a different light. That view is critical of the national lab as what might be termed a "zero competition supplier." I think this may be elaborated on further in the testimony you will hear today. If not, it might be worthy of further discussion, particularly in terms of what I said earlier about redefining the mission of the national laboratories. Part of any new definition of the mission should help clarify the competitive or noncompetitive aspects of the labs.

Also, it is important to bring out into the open and discuss more fully the matter of equitable policies regarding such matters as contract awards and accountability. Here we are dealing with criticism over the alleged privileged status of the national labs, in terms of their not being subject to the same type of review that industry contracts or university grants receive.

I think we must consider this criticism both honestly and fairly, determining where there may truly be unfair competition, but also distinguishing where the work and the roles played do require different treatment. A better understanding of this will go a long way toward laying the groundwork for future improvements in laboratory-industry cooperation and collaboration.

Perhaps the best collaboration might be the result of a three-way approach with the national lab as the initiator or the catalyst. The lab could identify this as one of its new missions. This three-way collaboration involving the lab, industry, and university could be a very straightforward matter. The labs have the research facilities, they are used to working with academic researchers, and they have the means, such as the contracting capability, to bring in the industrial arm. This may be the ideal way to go.

Let me conclude with a few comments on technology transfer by the national laboratories. The DOE labs actually have a long histo-

ry of technology transfer. It goes back some 35 years with the production and sale of radioisotopes.

At one time these Government facilities had the sole capability of producing about 100 such isotopes for sale to thousands of users here and abroad. By the late 1960's, most of this capability was established in competitive private industry.

The development of the light water reactor is another example of lab-to-industry transfer, perhaps the most significant one.

Most recently, the passage of the Stevenson-Wydler Technology Innovation Act of 1980 provides new impetus to, and a new mechanism for, technology transfer from the labs. This includes the establishment of an Office of Research and Technology Application at each major multiprogram lab.

Finally, eight DOE national laboratories are members of the Federal Laboratory Consortium, which has become a useful instrument of technology transfer. I think that if we work at all these initiatives, and use some imagination and cooperation to develop more, we can greatly amplify the creative output of our labs, our industry and our universities.

The key to all of this, I believe, may lie in three things: A penetrating new analysis of the lab's role in view of our new situation and needs; an increased willingness on the part of Government, industry, and academia to cooperate and collaborate for the greater good of the country; and the exercise of far more imagination and ingenuity in creating the institutional change necessary to meet the critical needs of our times and the future.

I believe we can meet this challenge, and I think that discussions such as we are having today are an essential part of this process. I am pleased to have the opportunity to participate in them. I look forward to hearing a diversity of views and worthwhile recommendations.

Mr. FUQUA. Thank you very much, Dr. Keyworth.

Now we will hear from Dr. Allan Bromley, Henry Ford II professor of physics at Yale University and also president of the National Association for the Advancement of Science.

Dr. Bromley?

Dr. BROMLEY. Thank you, Mr. Chairman, Madame Chairman.

[The biographical sketch of Dr. Bromley follows:]

DR. ALLAN BROMLEY

D. Allan Bromley is the Henry Ford II Professor of Physics at Yale University and Director of its Wright Nuclear Structure Laboratory. He is currently President of the American Association for the Advancement of Science and Vice President and of the International Union of Pure and Applied Physics. Prior to joining the Yale faculty in 1960 he held the position of Senior Research Officer at Atomic Energy of Canada, Canada's major national laboratory. He has served on visiting committees at the Lawrence Laboratory at Berkeley, The Argonne National Laboratory and during the past year served as Chairman of the Visiting Committee for Physics Accelerators and Instrumentation at the Brookhaven National Laboratory and Chairman of the Management Advisory Committee at the Oak Ridge National Laboratory. He holds a Ph.D degree from the University of Rochester and honorary doctorates from other universities in Germany, France, Canada and the United States.

STATEMENT OF DR. D. ALLAN BROMLEY, HENRY FORD II PROFESSOR OF PHYSICS, DEPARTMENT OF PHYSICS, YALE UNIVERSITY, NEW HAVEN, CONN.

Dr. BROMLEY. Let me begin by expressing to you and to the members of the subcommittees my appreciation of this opportunity of appearing before you.

I should begin, also, by emphasizing that although we in the United States no longer enjoy the world leadership in all fields of science and technology that we did for much of the interval since World War II, we still have overall, by a large margin, the strongest science and technology enterprise ever known.

In large measure, I believe that this is a consequence of the enlightened and generous support that this enterprise has received over the years from the Congress and, through you, from the U.S. taxpayers. And I am convinced that this investment, by the U.S. taxpayers, is one of the very best ones that they have ever made.

In considering the question before us this morning, I think that it is very difficult to improve on a statement made by President Truman to a joint session of the Congress on September 6, 1945, only 3 weeks after V–J Day, when he said, and let me quote:

> Progress in scientific research and development is an indispensable condition to the future welfare and security of the Nation. No nation can maintain a position of leadership in the world of today unless it develops to the full its scientific and technological resources. No government adequately meets its responsibilities unless it generously and intelligently supports the work of science in university, industry and in its own laboratories.

Already then, President Truman had focused on the three basic institutions charged with the scientific and technological well-being of the Nation; it is the health of this relationship among the three that concerns us today.

Since our focus is on the national laboratories, let me say at the outset that I consider them a national resource that is the envy of the world. They represent an almost irreplaceable body of knowledge, experience, and technology, and a remarkably able body of scientists and engineers.

I believe that the national laboratories have served us very well indeed, but times, conditions and missions change, and it is in this context that we meet today.

Let me turn, then, to this question of missions. That of the university is time-honored, and most easily defined; it is the discovery and dissemination of knowledge—research and teaching, if you will—research and teaching that are intimately mixed.

By their very nature, universities are self-renewing as student groups, both graduate and undergraduate, pass through their halls. Universities, again, by their very nature, have an indefinite lifetime.

Quality, of course, is another matter altogether. It is all too frequently forgotten that the quality of many departments, university, industrial, or national laboratory, depend critically on the efforts and presence of a very few, or even one, key individual.

The mission of researchers in private industry, I would submit, is also relatively easily defined. They, too, are engaged in the discovery of new knowledge, but, with rare exceptions, knowledge related to the general product lines of their industry. And they, through discovery, invention, and innovation, both in processes and prod-

ucts, are expected to contribute to the overall profitability of their organization.

The life cycle of private industries is a much less definite one than is that of universities, but economic realities force adjustments, changes, disappearance of missions, whenever they become unprofitable for any extended period. No industry can afford to continue indefinitely to provide a service or a product for which there is no longer a need or a market.

This, then, brings me to the national laboratories. Obviously, one of the original and continuing missions of several of the major DOE laboratories was related to national security, involving both security and massive scientific and technological activities. Emphasis here, of course, in recent years has shifted to the energy field.

Let me inject, Mr. Chairman, I, with your permission, will skip large sections of my prepared testimony and simply summarize for you.

Mr. FUQUA. Very good. We will make your entire text a part of the record, and if any of the other witnesses care to do that, I think it would expedite matters and we could get on to an interplay of questions at the end of the entire panel's presentation.

Dr. BROMLEY. Thank you, Mr. Chairman.

Others of the national laboratories had the original and continuing mission of making available to U.S. researchers—and, unfortunately, for many reasons, until very recently, this has meant university researchers almost exlusively—the major research facilities that were beyond the scope of the individual academic institutions, and without which some of the university researchers simply could not even approach the frontiers of their fields.

Over the years, of course, these missions have tended to merge as the laboratories have begun to make their facilities available to the national scientific community and as new facilities have been built in those laboratories with that sharing in mind.

Beyond these two primary missions—the major technological enterprises and the of provision major facilities for outside users—were two other missions. It was assumed that the national laboratories would undertake certain areas of research whose character and/or time scales—let me give as an example the programmatic measurement of cross sections for nuclear fusion and fission, essential to the energy program, which were such that they would neither fit comfortably in a university context where the research is frequently quantized around the 4- to 5-year program of a graduate student, or in a private industry, yet were of crucial national importance.

It was also understood from the beginning that the national laboratories represented a reservoir of highly talented, highly trained manpower, able to respond quickly and effectively to national emergencies and major problems.

But unlike the universities or private industries, national laboratories lack overt natural renewal mechanisms, and it has sometimes been difficult for them to disengage themselves gracefully from old missions or evolve comfortably into new ones. Some have been more successful in this respect than others.

I have been impressed, for example, by the speed and effectiveness with which large elements of the Oak Ridge Laboratory have

been transformed from a specific nuclear energy focus to the much more general focus on energy problems that we as a nation face.

I know that our national laboratories, their facilities and their personnel, represent an enormous national resource, but I perceive, Madame Chairman and Mr. Chairman, that this resource is currently underutilized.

While each of the national laboratories has areas and programs of very real excellence, of which they and we should be justly proud, there are other areas where the sense of direction, the focus, the motivation, the relevance to the Department of Energy mission, appear to be substantially less than they once were. This stems in part from what appears to be some confusion as to current missions, both in Washington and in the laboratories.

I would like to suggest, although I am aware of the enormous demands already made on him and on his office, that it might be appropriate if an overall review, covering all the national laboratories, not just those of the Department of Energy, were to be carried out under Dr. Keyworth's aegis with the goal of reexamining and perhaps recasting some facets of their missions so that their expertise and their strengths might be utilized in a more coherent fashion on some of the major energy-related and other problems that face the Nation.

Now let me return to one of the missions that I mentioned earlier, that of making major facilities available to the scientific community. With respect to the university community, I can only say that, in general, the laboratories have been remarkably successful, so much so that, in fact, our techniques of servicing university users are now being copied almost without change throughout the world—throughout the free world, certainly.

This service to the university community is a vastly more subtle, complex, and demanding matter than often appears on the surface. It has perhaps been most highly developed at Brookhaven, which is widely looked upon as setting world standards for user science support at major shared facilities.

Beyond providing access to a major facility, this support involves a very complex web of logistics, technical and engineering assistance, housing, and, most important of all, attitude of the in-house scientists and management.

The numbers of university-based personnel involved in these activities is impressive. During the past fiscal year, Argonne, Brookhaven, and Oak Ridge each list some 1,000 university-based persons in their respective programs. During a now-standard summer program at Brookhaven, representatives of some 200 colleges and universities participate in laboratory activities.

In Oak Ridge, 335 academic institutions were involved during the past fiscal year; of these, 71 were represented by graduate students, and 117 were undergraduates. It seems to me particularly important to emphasize this undergraduate number because exposing these young people to real research opportunities is what brings them, as professionals, into scientific and technological careers.

Obviously, these are headcounts, and the full-time equivalent would be less, but I know, for example, that at Oak Ridge during the last fiscal year, the management locally believes that some 20

percent of their entire scientific effort for the year came from outside users.

Let me emphasize, however, that the national laboratory instrumentation can never substitute entirely—except perhaps in the most instrumentation-intensive of fields, astrophysics with huge telescopes, particle physics with huge accelerators of the kind Dr. Keyworth mentioned—for complementary, university-based facilities.

Some of the scientific frontiers clearly remain within the university scope, and while graduate and undergraduate teaching can be accomplished using only national laboratory facilities, they can, in my opinion, be accomplished much better, more effectively and much more efficiently in a university-based facility, until and unless that research moves to the point where the national lab facilities are required for higher energies, greater intensities, other parameter ranges and the like.

Operating costs of the major facilities of the national laboratory, and the national demands on their available time, are such that it is very difficult to allow students to make mistakes and to benefit from them, or to allow them to follow their curiosity when it may lead away from a very carefully plotted research scenario. But I would submit that both of these are essential to the education of creative scientists, and both remain possible, within reason, at a university-based facility.

This question of complementing university facilities has led, and will certainly continue to lead, to friction in the university-national laboratory interface. As originally conceived, the national laboratories were to complement universities in facilities and in programs. But as some of the original demands on national laboratory personnel became less immediate, less onerous, their interests in fundamental science and their programs increasingly overlapped those of the university scientists.

While such an overlap is not intrinsically bad, the net result in this case, it seems to me, has been that unfortunately we have lost sight of much of the educational potential of this research, and more and more concentrated facilities in the national laboratories while allowing many formerly comparable university facilities to wither away to the point where they are no longer adequate for either research or education at the quality level we would like to see in this country.

Because of this, and because without adequately trained young people feeding into the system, in the future we will have neither the kind of national laboratory nor the kind of university, nor, indeed, industrial research that we would like, I believe that it is most important that we examine the relative roles of the national and university laboratories, emphasizing their complementary functions with national laboratories concentrating on mission-oriented programs directed toward national needs, and on large facilities which cannot be reasonably sited or administered within a university context.

These are difficult, but also very important questions, and they must be addressed in the near future. There is a growing realization in the country that typical instrumentation for research and

teaching in U.S. universities is now close to being, if not, indeed, already, obsolete.

I believe that it is essential that this instrumentation be modernized as rapidly as possible, and as a high priority Federal commitment. Obviously, I have a direct conflict of interest here, but I am convinced that only by doing this modernization can we reverse the dangerous decline in the number and quality of young people who are entering the physical sciences, engineering, and mathematics—fields where we are already experiencing critical shortages, and shortages which, given the condition of our educational enterprise at the present time, are going to get much worse in the coming decade.

I feel strongly, too, that in this modernization process we should not establish competing facilities in the national laboratories, but rather focus there on the larger, more demanding facilities that will complement and not duplicate those well suited for use on a university campus.

I mentioned earlier that research users of national laboratory facilities have, with few exceptions, come from the universities. Happily, in my view, this is now changing, and increasingly at the national laboratories we have come to expect industrial researchers, either working independently or working in collaboration with university and national laboratory groups.

At the new National Synchrotron Light Source at Brookhaven, for example, some 30 private industries are already actively engaged in research. Because a very large fraction of the industrial processes in this country are eventually limited by the behavior of materials at high temperature, the High Temperature Materials Laboratory being planned at Oak Ridge has attracted a similar, very deep interest on the part of the industrial community.

I would submit that such activities that bring university, industrial and national laboratory personnel together in research on common problems, common facilities, shared interests, are of national importance in at least two respects quite apart from the research that is being done.

First, they provide a milieu wherein members of all these three groups become sensitized to problems that the others encounter, and in doing so, they become much more effective partners in the search for solutions to national problems.

Second, while those few U.S. industries large enough to mount major research programs on their own have remained competitive in the international high technology marketplace, those of somewhat smaller size have found it very difficult, if not, indeed, impossible, to compete with foreign industries whose research and development activities receive direct Federal support or where their Federal governments, acted as brokers, have brought together a number of smaller industries with common research interests to form a critical mass, and then have provided the research support necessary to make them competitive—if not indeed more than competitive—internationally.

I would submit that the activities that we see beginning around the National Light Source and around the High Temperature Laboratory can serve as prototypes, bringing together U.S. industrial

groups with shared interests, and that this can yield handsome dividends in terms of our foreign balance-of-payment posture.

Just as I have argued many times in the past that mechanisms should be evolved to permit exchange of research personnel between universities and national laboratories, so also do I believe that, although they pose more problems, parallel mechanisms must be developed to foster temporary exchanges between industrial and national laboratories.

One of the stumbling blocks here has been the question of patents and proprietary rights. Industrial scientists are unlikely to take full advantage of a national laboratory facility if the results of their research subsequently become Government property.

But salutary change is taking place, albeit slowly. Current Department of Energy policies have been made much more flexible in this regard and industry is already responding. This, however, is an area, as is the tax area, that merits much further study.

Clearly much of this industrial, and indeed university, use of national lab facilities depends on the presence in those laboratories of specialized instrumentation, and this, Mr. Chairman, Madame Chairman, brings me to yet another long-standing problem area, that of instrumentation generally.

For several decades following World War II, we in the United States provided a world standard in instrumentation. When we visited foreign laboratories, we felt very much at home, because in a great many cases, the instrumentation we encountered was precisely the same as that we had in our own laboratories.

But beyond this, our instrumentation diffused very rapidly into other areas of U.S. society and technology. New instruments for the nuclear physicists were being used with at most a few years' delay in the intensive care ward of the neighborhood hospital. A very large fraction of this instrumentation came from the instrumentation divisions of the national laboratories.

Unhappily, all this has changed rather dramatically. Under the pressures of essentially flat dollar funding over the past decade, one laboratory research director after another has understandably sacrificed much of the long-term instrumentation activity in his laboratory to protect or salvage some of his ongoing, immediate research groups.

We are indeed living off our instrumentation capital in this country. We have lost much of our international preeminence in this important field, and we no longer have more than a few isolated groups with national responsibility for innovative instrumentation development.

I have long argued that as a Nation, we must rebuild some of this basic instrumentation development and, indeed, instrumentation research strength in our national laboratories.

In your invitation to appear before you this morning, among other things, you asked about the appropriateness of the distribution of funding among the three performers of energy research and development. As I understand it, in fiscal year 1981, total DOE operating support, via the Office of Energy Research, for university activities amounts to $201 million, and for national laboratory activities, amounts to $736 million.

Unfortunately, however, as you well know, there are very great difficulties in converting these numbers into a fair comparison. For example, a significant fraction of the national laboratory total is used in providing service for university users.

So let me, instead, approach your question from a much more visceral sense. I would have to say that the relative levels of effort in the university and the national laboratory research enterprises, evolving under strong budget pressures in recent years, are not wildly wrong. However, it does seem to me that the universities have been considerably more seriously impacted by budget pressures than have the national laboratories. I know that there will be some difference of opinion on this.

But particularly in view of the critical need to expand U.S. production of physical scientists, engineers and mathemeticians referred to earlier, some redressing of this balance between the universities and the national laboratories may be indicated.

Let me take a specific example from my own field of nuclear physics. It has been well over a decade since the Department of Energy made a new start in terms of any major new instrumentation at any U.S. university. This has certainly not been the case in the national laboratories.

In 1969 there were 90 clearly identifiable U.S. university-based facilities supporting in-house nuclear science research programs. This number is now substantially less than 30, and there has been no comparable reduction in the national laboratories.

I would submit that if the Nation's universities are to be able to respond to the need for a larger flow of trained personnel in the sciences and engineering, and if they are to attract the junior faculty that plays such an important role in educating these students, it is essential that high priority be given to modernization of university facilities.

In concluding, let me say that I believe deeply that this question of maintaining an adequate flow of trained personnel, of improving the quality of our educational system, represents one of the most pressing challenges that faces us as a Nation today.

In my prepared testimony, Mr. Chairman, Madam Chairman, I have listed in "bullet" form some of my major points. I will not take the time to repeat them here.

Let me only, in concluding, thank both of you for giving me the opportunity to appear before you to present what are, indeed, my personal views on these important questions. Thank you.

[The prepared statement of Dr. Bromley follows:]

Statement by

D. ALLAN BROMLEY

Madame Chairman, Mr. Chairman, Members of the Subcommittees, I should like to begin by expressing to you my appreciation of this opportunity to appear before you.

I should begin by emphasizing that although we, in the United States, no longer enjoy the world leadership in all fields of science and technology that we did for much of the interval since World War II, we still have, overall, by far the strongest science and technology enterprise ever known. This is, in large measure, a consequence of the enlightened and generous support provided to that enterprise, over the years, from the Congress, and indirectly from the U. S. taxpayers. I am convinced that it has been one of the very best investments that these taxpayers have ever made.

It is hard to improve on President Truman's statement to a joint session of the Congress on September 6, 1945--only three weeks after V-J Day--when he said:

> "Progress in scientific research and development is an indispensable condition to the future welfare and security of the Nation. --No nation can maintain a position of leadership in the world of today unless it develops to the full its scientific and technological resources. No government adequately meets its responsibilities unless it generously and intelligently supports the work of science in university, industry and in its own laboratories."

Already President Truman had focussed on the three basic institutions charged with the scientifc and technological well-being of the Nation; it is the health of the relationship among the three that concerns us today.

Since our focus is on the national laboratories let me say, at the outset, that I consider them a national resource that is the envy of the world; they represent an almost irreplaceable body of knowledge, experience and technology and a remarkably able body of scientists and engineers. The national laboratories have served us very well indeed. But times, conditions and missions change and it is in this context that we meet today.

Let me turn to this question of missions, one that will be central to all my remarks this morning. That of the universities is time-honored and most easily defined; it is the discovery and dissemination of knowledge--research and teaching, if you will. The research and teaching are intimately mixed; without personal research activity the teaching of any individual rapidly becomes sterile; and continued contact with alert questioning young minds in teaching is the best tonic and stimulus for which any researcher can ask. By their very nature, universities are self-renewing as student groups, undergraduate and graduate, follow one another through their halls and as the frontiers of science move their teaching and research along. Universities have an indefinite lifetime. Quality of course is another matter. It is all too frequently forgotten that the quality of many university departments depends critically upon the presence of one, or perhaps a few key faculty members. If they disappear, for whatever reason the quality

of both research and teaching can change overnight.

The mission of researchers in private industry is also relatively easily defined. They, too, are engaged in discovering new knowledge but, with rare exceptions, knowledge related to the general product lines of their industry. And they, through discovery, invention, and innovation--both in processes and products--are expected to contribute to the overall profitability of their organization. Through their work and their contact with the broader scientific and technical communities they can, of course, also contribute substantially to the public image of the organization. Although industrial research organizations span a huge range of sizes, structures and fields they again depend critically for their effectiveness and quality on the efforts of a small number of key personnel.

The life cycle of private industries is much less definite than that of universities but economic realities force adjustments, change, and disappearance of missions whenever they become unprofitable for any extended period. No industry can afford to continue, indefinitely, to provide a service or a product for which there is no longer a need or market.

Because industrial research is generally targetted, it follows that private industry will not necessarily allocate optimal resources to research and development in all areas that are of national interest. Even in the targetted areas it is generally true that the overall benefits to the nation of much, although not all, long range research and development certainly exceed the benefits to the

organization that paid for it. This tends to work against private investment particularly in this long range research and development; so also does the fact that it is intrinsically high risk. Increasingly, too, in agreement with Hayes and Abernathy of Harvard, I feel that current management philosophers in this country, with their emphasis on short term evaluation and payoff, mitigate against significant investment in long term research and development. And, finally, in many of the frontier areas of science and technology the scale of the instrumentation--the capital investment required--is beyond the scope of all but perhaps the very largest of the private sector organizations--just as it is beyond the scope of the universities.

This brings me to the national laboratories--and particularly those of the Department of Energy under discussion this morning. I should add, parenthetically, that I am ill equipped, by either experience or detailed knowledge, to comment on other than the DOE laboratories; consequently I regret that I have been, in the time available, simply unable to make the comparative examination that I know was part of your request prior to this Hearing.

Obviously one of the original--and continuing--missions of several of the major DOE laboratories, (e.g. Los Alamos, Oak Ridge, Argonne, Lawrence Livermore) was related to national security, involving both secrecy and massive scientific and technological activities. Others (e.g. Brookhaven, Fermi, SLAC-Stanford, Lawrence Berkeley) had the original--and continuing--mission of making available to U.S. researchers (and until rather recently this, for whatever reasons,

meant almost exclusively university researchers) major research facilities beyond the scope of the individual academic institution, and without which the university researchers simply could not even approach the frontiers of their fields. Over the years these missions have tended to merge as the former laboratories also began to make their facilities available to the national scientific community and to develop new facilities with this in mind. The major differentiation now is between single-purpose (eg. Fermi and SLAC) whose sole function is long range fundamental research and multi purpose (eg. Oak Ridge, Argonne, and Los Alamos), whose functions span a very broad range from very basic to very applied, from research through development to demonstration, and, increasingly, on behalf of many federal agencies. Brookhaven and Berkeley are examples of laboratories which fall between these extremes.

Beyond the two primary missions just discussed were two others. It was assumed that the national laboratories would undertake certain areas of research whose character and/or time scales (e.g. programmatic measurement of cross sections required in fission and fusion energy research) were such that they neither fit comfortably in a university context where research is frequently quantized around the four to five year program of a given student nor appealed to any private industry yet were of crucial national importance. And it was understood that the national laboratories represented a reservoir of highly talented, highly trained, manpower available to respond quickly and effectively to major national problems and emergencies.

Unlike the universities or private industries, national laboratories lack overt natural renewal mechanism and it has sometimes been difficult for them to disengage themselves gracefully from old missions or evolve comfortably into new ones. Some have been much more successful in this respect than others. I have been impressed, for example, by the speed and effectiveness with which large elements of the Oak Ridge National Laboratory have been transformed from a specific nuclear energy focus to one on the much more general energy problems that we, as a nation, face.

I know that our national laboratories--their facilities and their personnel--represent an enormous national resource but I perceive, Mr. Chairman, Madame Chairman that this resource is currently underutilized. While each of the national laboratories has areas and programs of very real excellence, of which they, and we, should be justly proud, there are other areas where the sense of direction, the focus, the motivation, the relevance to the Department of Energy mission appear to be substantially less than they once were. This stems in part from what appears to be some confusion as to current missions--both in Washington and in the laboratories. I should like to suggest, although I am aware of the already enormous demands upon him and upon his office, that it might be appropriate if an overall review, covering all the national laboratories, not just those of DOE, were to be carried out under Dr. Keyworth's aegis with the goal of reexamining and perhaps recasting some facts of their missions so that their expertise and strengths might be utilized in more coherent fashion on some of the major energy related--and other--problems facing

the nation. I have long felt, for example, that the uncertainty concerning the future of various projects in some of the national laboratories, as policy here in Washington changed--although sometimes unavoidable--was both wasteful of talent and resources as well as very demoralizing for not only the scientific and engineering personnel involved but also the laboratory management and administration.

Let me now return to one of the major missions that I mentioned earlier--that of making major facilities available to the scientific community. With respect to the university community I can only say that, in general, the laboratories have been remarkably successful, so much so that our user arrangements are being copied, almost without change, throughout much of the world. This service to the university community, which is a vastly more subtle, complex and delicate matter than it appears on the surface, has been perhaps most highly developed at Brookhaven which is widely looked upon as setting world standards for user scientist support at major shared facilities. Beyond providing access to a frontier facility--as a result of decisions made by policy and program committees democratically elected from the potential user community--this support involves a complex web of logistics, technical and engineering assistance, housing, and most important of all, attitude of in-house scientists and management.

That university users were expected to dominate utilization of the Brookhaven facilities for example, is reflected in some of the most widely recognized discoveries made there. The fact that there was more than one kind

of neutrino in nature was discovered by a group from Columbia University; that time reversal invariance did not hold was shown by a Princeton University group (Fitch and Cronin received the 1980 Nobel Prize for this work); that a totally new fundamental building block of nature was required--the quark--to understand the newly discovered J particle, was found by an MIT group (Ting, with Richter of Stanford, received the 1976 Nobel Prize for this work); that the omega minus particle--required by Gellmann's synthesis of the elementary particle zoo--actually existed in nature was shown by a Brookhaven group. In only one of these 4 major research programs, programs that have profoundly affected our view of nature, were Brookhaven researchers the dominant ones. In-house researchers have played--and still play--a much more dominant role and have been responsible for a larger fraction of the major discoveries at others of the national laboratories, however.

Nationally, the numbers of faculty and students utilizing national laboratory facilities each year is impressive. During FY1980 Argonne, Brookhaven and Oak Ridge each list some 1000 university-based persons as having engaged in research for some period of time at one or other of their facilities. During its now standard summer program, Brookhaven typically hosts faculty and students from about 200 colleges and universities; during FY1980 Oak Ridge hosted representatives of some 345 academic institutions of whom 71 were graduate students and 117 were undergraduates. This undergraduate experience is particularly important in attracting some of the very best young people in the country into

scientific and technological careers.

Obviously these are head counts and the total effort is less than these figures might suggest. At Oak Ridge, however, detailed accounting shows that some 450 person--years of scientific activity came from the university community in FY1980 corresponding to about 20% of the scientific staff of that laboratory.

The national laboratories are playing a vital role in making facilities available to these academic researchers. In field after field, as the frontiers move forward, the instrumentation necessary to reach some of these frontiers moves beyond any single university or college: only the national laboratories can evolve, maintain and support such instrumentation effectively and efficiently.

But let me emphasize that this national laboratory instrumentation can never substitute entirely--except perhaps in the most instrumentation--intensive of fields such as astrophysics and particle physics--for complementary university based facilities. Some of the frontiers, as I have just suggested clearly remain within university scope. And while graduate and undergraduate teaching and research can be accomplished using only national laboratory facilities they can, in my opinion, be accomplished much better, more effectively and much more efficiently in a university based facility--until and unless the research moves to the point where the national laboratory equipment is needed to complement that of the university at higher energies, greater intensities, other parameter ranges and the like. Operating costs of the major facilities at a national laboratory and the demands for their available time are such that it is very difficult to allow students to make

mistakes and benefit from them--or to follow their curiosity when it may lead away from a carefully plotted research scenario. But these are both essential to the education of creative scientists--and both remain possible, within reason, in the university--based facility.

This question of complementing university facilities has led, and will continue to lead, to friction in the university-national laboratory interface. As orginally conceived the national laboratories were to complement universities in facilities and programs. But as some of the original demands on national laboratory personnel became less immediate and less onerous, their interests in fundamental science increasingly overlapped those of the university scientists. Over the years complementarity in many areas has changed to a rather unequal, and sometimes unhappy, competition in which university and national laboratory personnel have engaged in precisely the same research but wherein the latter have more time, better facilities, better technical support, fewer distractions and essentially no competing obligations. National laboratory management people have argued that such freedom is necessary if they are to retain their most talented scientists so that they would spend at least part of their time on projects that might be more directly applied or mission related--and be available to respond when national emergencies might make special demands on the laboratories.

University scientists have argued that the competition was unfair and unnecessary and that only the fact that they had students allowed them to compete

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with any degree of success. While balancing teaching, committee and research obligations, indeed, the university scientists have sometimes felt that their national laboratory colleagues, free to focus their full energies on research of their choosing, effectively had the benefits of lifetime fellowships.

These are difficult and very important questions which must be addressed in the near future. There is a growing realization that typical instrumentation for research and teaching in U. S. universities is now close to being, if not indeed already, obsolete. I believe that it is essential that this instrumentation be modernized as rapidly as possible, and as a high priority federal commitment. Obviously I have a direct conflict of interest here, but I am convinced that only by doing so can we reverse the dangerous decline in the number and quality of our students who are entering the physical sciences, mathematics and engineering, fields where we are already experiencing critical shortages of trained personnel, shortages--given our present educational situation--that will inevitably get worse in the decades of the 1980's.

I feel strongly that in modernizing this university instrumentation we should not establish competing facilities in the national laboratories but, rather, focus there on larger or more demanding facilities which will complement and extend those suitable for installation on a university campus.

Obviously, there will continue to be a vital role for the national laboratories in this university-laboratory interface. I believe firmly that there must be more contact and interaction rather than less--that mechanisms should be developed and implemented whereby some laboratory personnel are engaged regularly in

teaching and research activities in the universities to complement university engagement in the laboratories. This could have the all - important result of sensitizing both groups to the responsibilities and demands upon each other.

I mentioned earlier that research users of national laboratory facilities have, with few exceptions, been drawn from universities; happily this is changing and researchers from private industry are increasingly evident as users--either independently or in collaboration with university groups. At the new National Synchrotron Light Source (NSLS) facility at Brookhaven some thirty private industries are now actively involved in preliminary research and in the development of the new instrumentation that will bring this powerful new national facility to bear on their specific problems.

Reflecting the fact that almost every industrial process in this country is ultimately limited in its efficiency, and/or cost, by the high temperature behaviour of materials, the planned national High Temperature Materials Laboratory (HTML) and the already existing research program in this area at the Oak Ridge National Laboratory have attracted widespread interest in the industrial research community. Equal interest comes from the university community inasmuch as there is an enormous amount of basic research that remains to be done in this area--largely because the necessary facilities--to be provided in this new national facility--have never before been available to any significant number of users--if indeed, at all.

Such activities, that bring university, industrial and national laboratory personnel together in research on common problems and shared interests are

of national importance in at least two major senses. First, they provide a milieu wherein members of all three groups become sensitized to problems in the other areas and thus more effective partners in the search for solutions to national problems. Second, while those U. S. industries large enough to mount major research activities on their own have remained competitive in the international, high technology market place, those of somewhat smaller size have found it very difficult, if not impossible, to compete with foreign industries whose research and development activities received direct federal support or where the federal governments acted as brokers, bringing together a number of smaller industries with common research interests and potential to form a critical mass and then providing the research support necessary to make them competitive internationally. The activities now centering on facilities such as the NSLS and HTML can serve as prototypes bringing together U. S. industrial groups with shared interests . This can yield handsome dividends in terms of our foreign balance of payments posture.

Just as I have argued that mechanisms should be evolved to permit temporary exchange of research personnel between universities and national laboratories, so also do I believe that, although they may pose more problems, parallel mechanisms should be developed to foster temporary exchanges between industrial laboratories and national laboratories. Although not part of our discussions today, the industry--university interface is equally in need of attention.

One of the stumbling blocks here has been the question of patents and of proprietary rights. Industrial scientists are unlikely to take anything like full advantage of a national laboratory facility if the results of their research subsequently become government property. But salutary change is taking place--albeit

slowly. Current DOE policy states that industry is able to use the facilities of its national laboratories provided (a) that such facilities cannot be supplied by commercial institutions and (b) that industry pay the full cost of the use of the equipment. Under these circumstances industry can retain the proprietary rights to the research it carries out and is under no obligation to publish the results in the open literature. Under such conditions, at Oak Ridge, for example, duPont and Firestone are examining polyners using the national small angle neutron scattering equipment; Exxon is studying coal structure using specialized electron spin resonance facilities and mass spectrometric capabilities; IBM is using the low-level counting facility to study alpha emitters in high purity silicon; and the General Public Utility is taking advantage of unique ORNL capabilities in radionuclide measurements in the course of its clean-up operation at Three Mile Island.

Clearly much of this use depends upon unique national laboratory capabilities in specialized instrumentation. This, Mr. and Madame Chairman brings me to yet another long standing problem area--that of instrumentation generally.

For several decades following World War II U. S. instrumentation provided a world standard. U. S. scientists visiting foreign laboratories felt very much at home; the instrumentation was frequently identical to that in their own laboratories. Beyond this, instrumentation diffused very rapidly into other areas of U. S. science and technology. New instruments for the nuclear physicist were being used with at most a few years delay, in the intensive care ward of the neighborhood hospital. And a very large fraction of them came from the instrumentation divisions

of the national laboratories.

Each of the laboratories, then operational, had collected a group of talented individuals who had learned about instrumentation and electronics in the radar and Manhattan projects. With the advent of the transistor, these groups midwived the very rapid transition from vacuum tube to solid state electronics, first for research in the laboratories themselves, but later, as it diffused from the laboratories to the universities and industry, for a much wider constituency. And these groups served as the source of a large number of technological entrepreneurs who established small businesses, many now familiar names worldwide, in the high technology instrumentation areas.

Unhappily all this has changed rather dramatically. Under the pressures of essentially flat dollar funding over the past decade, one research director after another has understandably sacrificed much of the long term instrumentation activity in his laboratory to protect or salvage some of his ongoing immediate research groups. We are indeed living off of our instrumentation capital. We have lost much of our international preeminence, and we no longer have more than a very few isolated groups with national responsibility available to perform the comparable midwifery in taking us from the transistor era to that of very large scale integrated circuitry (VLSI) and the microprocessor.

I have long argued that as a nation, we cannot afford not to rebuild some of this basic instrumentation development and, indeed, instrumentation research strength in our national laboratories. A relatively small investment would, I believe, return very handsome dividends in better, more effective and more

widespread utilization of some of the contemporary marvels in semiconductor and computer technology throughout science, technology and our society.

Let me return for a moment to a point I raised earlier, namely, the worsening shortage of trained personnel in the physical sciences, engineering and mathematics. I have emphasized, above, how critically dependent the quality of any research endeavour is upon the quality and stature of its leading figures; and I have serious concerns about the ability of our educational system to attract an adequate number of students into these areas--or having attracted them--to give them an internationally competitive education. Again remembering and emphasizing my direct conflict of interest I would like to suggest that improving the quality (and quantity) of U. S. education in science and technology represents one of our most pressing challenges for the future.

In your invitation to appear before you you asked, among other things about the appropriateness of the distribution of finding among the three performers of energy research and development. Without having available to me much more detailed information than I do, I could not hope to give you more than very general impressions. As I understand it, in FY1981, total DOE operating support via the Office of Energy Research for university activities amounts to 201 million dollars; the corresponding number to the national laboratories is 736 million. Unfortunately, there are very great difficulties involved in making any fair comparison of what these numbers actually mean. For example, a significant fraction of the national laboratory number is utilized in funding service to university users. Again it would take a much more detailed analysis

than I have been able to carry through before I could directly relate these numbers to levels of effort in the two institutional classes.

Approaching the question then from a somewhat different viewpoint I would have to say that the relative levels of effort in the university and national laboratory research enterprises, evolving under strong budget pressures in recent years, are certainly not wildly wrong. However, it seems to me that the universities have been considerably more severely impacted by budget pressures than have the national laboratories and that, particularly in view of the critical need for expanded production of personnel in physical sciences, engineering and mathematics referred to above, some redressing of the balance may be indicated. To take a specific example from my own field of nuclear physics; in 1969 there were some 90 clearly identifiable U. S. university based facilities supporting in house research programs; this number is now less than 30; no comparable reduction occurred in the national laboratories and indeed a substantial fraction of the scientists displaced when these university facilities closed, did move their remaining research activities, albeit at lower level, to one of the national laboratories.

If the nation's universities are to be able to respond to the need for a larger flow of trained personnel in the sciences and engineering--and to attract the junior faculty that play such an imporant role in educating these students--it is essential that high priority be given to modernization of university facilities.

Let me then, if I may, attempt to summarize my main points and suggestions:

- The DOE national laboratories represent a major national resource of knowledge, experience and expertise as well as of highly trained able people. They have served the nation well.

- Lacking overt mechanism for self-renewal some aspects of this resource are currently underutilized in addressing the nation's problems.

- An overall review of the missions of the national laboratories under the aegis of the Office of Science and Technology Policy could have very beneficial effects.

- The national laboratories play an essential role in making available to university and industrial researchers large, frontier facilities that are beyond the scope of all but a very few of the universities and industries involved.

- The university, national laboratory and industrial research communities form a mutually supportive and complementary triumvirate but their interactions can be improved and the individual components strengthened.

- Direct competition between university and national laboratory research should be minimized.

- University based research instrumentation is, or is rapidly becoming, obsolete and in need of modernization; complementarity should be emphasized wherever possible in this modernization.

- Mechanisms should be evolved to foster more exchanges--both short and long term--of research personnel among university, national and industrial laboratories.

- Increased industrial utilization of unique national laboratory research facilities is beneficial to all involved, university, national laboratory or industrially based and should be fostered.

- Research and development activities in instrumentation itself merit strengthening both in personnel and in resource allocation within the national laboratories.

- Provision of an adequate flow of trained personnel in physical science, engineering and mathematics from the universities is a critical national issue and its assurance merits high priority and visibility in national fora.

- Balance between levels of research effort in universities and national laboratories is not qualitatively wrong, but universities have been impacted more heavily by budget limitations during the past decade and some redress is in order, particularly in the light of the preceding conclusion.

Madame Chairman, Mr. Chairman, let me again thank you for this opportunity to come before you to present my personal views on a very important topic.

Mr. FUQUA. Thank you very much, Dr. Bromley.

Now we will hear from Dr. Art Bueche, the senior vice president, Corporate Technology, the General Electric Co.

Art, we're happy to welcome you back to our committee once again, and we'll be very pleased to hear your testimony.

Dr. BUECHE. Thank you very much, Mr. Chairman.

Mr. FUQUA. If you care to summarize, we will make your statement a part of the record in its entirety.

Dr. BUECHE. Thank you.

STATEMENT OF DR. ARTHUR M. BUECHE, SENIOR VICE PRESIDENT, CORPORATE TECHNOLOGY, THE GENERAL ELECTRIC CO.

Dr. BUECHE. Madame Chairman, Mr. Chairman and members of the committee, Mr. McKelvain and I appreciate this opportunity to share some of our views on the role of the DOE national laboratories in maintaining the Nation's overall leadership in energy science and technology.

First, I would like to provide some background on the role of the Federal labs in the development of industrial technology, then review the recent trends in the use of DOE labs and, finally, suggest a course of action aimed at improving the efficiency of DOE's energy R. & D.

Historically, the goal of most federally-performed R. & D. has been to help develop technology needed to accomplish the direct missions of the Federal Government. Because of extraordinary security requirements and the need to establish long-term institutional capabilities unique to our nuclear weapons programs, this country developed a system of national laboratories with unparalleled competences and facilities in many scientific and technical disciplines.

Their accomplishments in gaining many years of technological lead for our Nation's defense program have commanded the respect and the admiration of people throughout the world, and I must say my hat's off to them.

As the AEC became involved in nuclear power, the weapons-related technology and facilities of the laboratories were essential

elements of our national program. The technology moved rapidly and efficiently due to the superb capabilities of the AEC labs and the existing working relationship between the AEC and industrial contractors, some of whom were also in the business of providing power generation equipment to the Nation's utilities.

While some may argue that the AEC's leadership role in managing and pacing the introduction of nuclear energy technology led to many of the problems which now confront nuclear power, it has to be acknowledged that Government and industry collaboration in bringing a technology to the marketplace was effectively demonstrated.

Just quickly, another success model for industry-Government collaboration in a similarly major commercial technology is the National Advisory Committee for Aeronautics. The activities of the NACA are accorded a leading role in development of the modern aerospace industry, one of the few areas in which we continue to enjoy undisputed technological leadership and overwhelming dominance of the international marketplace.

In my view, a critical factor in the success of the NACA was the collaborative role of industry in the planning and management of such programs.

But models are useful only to a limited extent. It must be remembered that the DOE does not have the mission of supplying energy in our economy. It is not the principal customer for energy technology. It does not provide a market for leading-edge technologies as was true for NASA and DOD, and thus it has no direct stake in the technical or economic performance of the technology which it is paying to have developed.

Technology applicable to our energy needs is as diverse as their applications. At one extreme, for example, are the fairly unsophisticated technology needs of some conservation and solar techniques. Here diverse industrial involvement is certainly appropriate. The rate of adoption of these techniques is largely a function of prevailing and anticipated economic conditions and energy pricing structures.

At the other extreme, we have the breeder, fusion, and advanced solar energy, where both the technical and the economic risks are very high.

Across this entire spectrum, however, we now have a remarkably strong private structure and tradition for the conduct of R. & D., for the commercialization of resulting technologies, and for the delivery of energy to the public through the operation of the market system, although highly regulated in some instances.

Federal involvement is warranted in some cases; for instance, in the support of basic research and in funding those high-risk, long-range technologies deemed to be important to the Nation, but such participation should be on a cooperative basis with industry and universities, rather than unilateral direction by Government alone.

Madame Chairman, Mr. Chairman, I congratulate you and the members for taking a new look at the issue of DOE labs. I think some changes could improve the rate at which we are finding solutions to our energy problems and, at the same time, help to solve other serious national problems. I refer here to the deterioration of our universities and the need to accelerate the utilization of

research to increase productivity at home and make us more competitive internationally, to create jobs and better living conditions for us all.

I believe that increased utilization of the universities could provide part of the support for their revitalization and help to create the trained young people who will move into the private sector with ideas and skills for the future.

The technology transfer problem is serious and we do need solutions, but rather than spend all this time and effort in devising ways of transferring energy technology from Government labs to private labs, why not eliminate the barrier by placing more of the work in the private labs to begin with?

There are sometimes good arguments to be made for using the national labs to get a fast start or to take advantage of a unique competence, or because of a lack of private capabilities. On the other hand, if the capability is needed in the private sector, the time required to establish it may well be less than that lost in trying to transfer any resulting technology to commercial use and public benefit. Unfortunately, we appear to have been moving in the wrong direction.

Although the private sector has existing or potential capabilities in most energy-related technologies, we have seen a decreasing share of Federal energy R. & D. performed in industry. NSF data show that in 1974, 64 percent of Federal energy R. & D. was performed by industry, but by 1979, the industry share had fallen to 38 percent.

To try to understand this, we looked at the data for DOE's 12 multiprogram laboratories. Other DOE R. & D. institutions include 7 fossil energy technology centers, 4 physical research facilities, 2 solar energy facilities, a fusion energy facility, a nuclear energy engineering center, and 12 biomedical and environmental facilities.

Frankly, Mr. McKelvain and I haven't had time to look at all of these; however, tables appended to your copy of these remarks indicate there may be a considerable amount of duplication and overlap in the 12 multiprogram laboratories themselves, as well as these 27 other DOE institutions.

I could go on here, Mr. Chairman, with all of these numbers and statistics and tell you about how the laboratory staffs have grown, how they've grown in spite of some shrinking in the funds available, which indicates that the balance between federally funded work and universities and industry relative to government installations has been changing radically in favor of government installations.

Now we are faced with a significantly larger reduction in the DOE energy budget for 1982 and, if past trends continue, a much smaller share of a much smaller resource will remain for performance of R. & D. in the universities and industry.

I would ask, is that bad? In my view, it is.

With the anticipated reductions, even the DOE laboratories must be cut back. As reductions are made, the inherent difficulty in setting priorities on the basis of technical and economic feasibility will become even more of a problem to the overall DOE program. At the same time, the more severe the cutbacks required for work

in the universities, the more we will have greater shortages of the bright young people needed to provide the ideas for tomorrow.

This isn't meant to cast aspersions on the many fine people engaged in energy R. & D. in the national laboratories. I think they are just great. The problem is to find out how to utilize the same resources in a more effective way to accomplish our ends.

I've been pleased with the obvious efforts of some of the DOE management and some of the laboratory directors to achieve closer interaction between the labs and industrial research.

But the challenge is to devise a framework for the future of these national labs that will continue to give us the advantages of their existing unique technical competences and facilities. We must let them focus their full attention to those areas where special circumstances make it appropriate for them to be directly involved, but at the same time, to achieve organization arrangements and understandings that will permit them to operate in support of, or as an adjunct to, the private sector leadership in those technologies that have a commercial objective.

Now to get down to the "meat" of it. I would like to make the following proposals for specific action:

One, the Department of Energy should adopt the following policies:

No further energy centers will be established.

Second, all commercially oriented energy technology development programs that do not have significant participation by industry or universities will be phased out by the end of 1982.

Next, all programs within 7 years of commercialization must be placed under prime contract or joint management with industry beginning in 1983. Joint industry-university participation should be encouraged.

DOE energy R. & D. facilities will be made available to private industry and universities on a reimbursable and proprietary basis for the conduct of research and experimentation when this work is deemed by the laboratory and the DOE to be in the national interest.

I propose that the Secretary of Energy should request the Director of the Office of Science and Technology Policy to appoint a review board comprised of energy industry executives and university research leaders to identify programs in the DOE labs and centers which should be canceled due to lack of technical and/or commercial feasiblity, transferred to prime contracts with industry or universities—and, if appropriate, portions which should be subcontracted back to the DOE labs—or phased out if industrial participation in funding support is not forthcoming.

The review board would also advise the Secretary on the establishment of guidelines for the use of DOE R. & D. facilities by private industry and universities and would review and report to the Secretary on the implementation of the policy.

In short, Madame Chairman and Mr. Chairman, I think it's high time we took a hard look at these laboratories and began to think about transferring the work and the people to the university campuses and industry where we can produce more of the kind of people we need, and where the work can be more expeditiously commercialized.

Once again, let me say how much I appreciate this opportunity to present my views, and I will do my best to answer your questions in regard to the suggestions I've made. Thank you.

[The prepared statement of Dr. Bueche follows:]

Statement of

DR. ARTHUR M. BUECHE
Senior Vice President-Corporate Technology
The General Electric Company

My name is Arthur M. Bueche. I have been associated with the General Electric Company for the past 31 years and presently serve as the Company's Senior Vice President for Corporate Technology.

With me this morning is a member of the GE Corporate Staff, Mr. Boyd J. McKelvain. Mr. McKelvain served as Consultant to the Science and Technology Team which I directed during the Reagan Transition period. He performed our assessment of energy policy including policy governing the use of the National Laboratories. He has extensive experience in high-technology industry and was a senior official of the nuclear sector of the Energy Research and Development Administration.

We appreciate this opportunity to share some of our views on the role of the DOE National Laboratories in maintainiing the nation's overall leadership in energy science and technology.

First, I would like to provide some background on the role of Federal Laboratories in the development of industrial technology, then review the recent trends in the use of the DOE Laboratories, and finally suggest a course of action aimed at improving the efficiency of DOE's energy R&D.

Historically, the goal of most federally-performed R&D has been to help develop technology needed to accomplish the direct missions of the Federal Government. Because of extraordinary security requirements and the need to establish long-term institutional capabilities unique to our nuclear weapons programs, this country developed a system of national laboratories with unparalleled competences and facilities in many scientific and technical disciplines. Their accomplishments in gaining many years of technological lead for our nation's defense program have commanded the respect and admiration of people throughout the world. And my hat is off to them.

As the AEC became involved in nuclear power, the weapons-related technology and facilities of the Laboratories were essential elements of our national program. The technology moved rapidly and efficiently due to the superb capabilities of the AEC Labs and the existing working relationship between the AEC and industrial contractors, some of whom were also in the business of providing power generation equipment to the nation's utilities.

While some may argue that the AEC's leadership role in managing and pacing the introduction of nuclear energy technology led to many of the problems which now confront

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nuclear power, it must be acknowledged that government and industry collaboration in bringing a technology to the marketplace was effectively demonstrated.

Another success model for industry/government collaboration in a similarly major commercial technology is the National Advisory Committee for Aeronautics. The activities of the NACA are accorded a leading role in development of the modern aerospace industry -- one of the few areas in which we continue to enjoy undisputed technological leadership and overwhelming dominance of the international marketplace.

In my view, a critical factor in the success of the NACA was the collaborative role of industry in the planning and management of programs. The agency existed to support both military and commercial technology under conditions where the same industrial participants supplied aircraft to the government for military applications and to the commercial air transportation market. Also, expensive and unique facilities were made available for use by private sector competitors.

But models are useful only to a limited extent. It must be remembered that the DOE does not have the mission of supplying energy in our economy, is not the principal customer for energy technology, does not provide a market for leading

edge technologies as was true for NASA and DOD, and thus has no direct stake in the technical or economic performance of the technology which it is paying to have developed.

Technology applicable to our energy needs is as diverse as the applications. At one extreme for example, are the fairly unsophisticated technology needs of some conservation and solar techniques. Here diverse industrial involvement is appropriate. The rate of adoption of these techniques is largely a function of prevailing and anticipated economic conditions and energy pricing structure. At the other extreme we have the breeder, fusion, and advanced solar energy where both the technical and economic risks are very high.

Across this entire spectrum, however, we now have a remarkably strong private structure -- and tradition -- for the conduct of R&D, for the commercialization of resulting technologies, and for the delivery of energy to the public through the operation of the market system, although highly regulated in some instances. Federal involvement is warranted in some cases -- e.g. in the support of basic research and in funding those high-risk, long-range technologies deemed to be important to the nation -- but such participation should be on a cooperative basis with industry and universities, rather than unilateral direction by government alone.

Madam Chairman and Mr. Chairman, I congratulate you and the members for taking a new look at the issue of the DOE Labs. I think some changes could improve the rate at which we are finding solutions to our energy problems and, at the same time, help to solve other serious national problems. I refer to the deterioration of our universities and the need to accelerate the utilization of research to increase productivity at home and make us more competitive internationally.

I believe that increased utilization of the universities could provide part of the support for their revitalization and help to create the trained young people who will move into the private sector with ideas and skills for the future.

The technology transfer problem is serious and we do need solutions, but rather than spend all this time and effort in devising ways of transferring energy technology from government labs to private labs, why not eliminate the barrier by placing more of the work in the private labs to begin with?

There are sometimes good arguments to be made for using the National Labs to get a fast start, or to take advantage of a unique competence, or because of a lack of private capabilities. On the other hand, if the capability is needed in the private sector, the time required to establish it may well be less than that lost in trying to transfer any resulting technology to commercial use and public benefit.

Unfortunately, we appear to have been moving in the wrong direction.

Recent DOE Trends

Although the private sector has existing or potential capabilities in most energy-related technologies, we have seen a decreasing share of Federal energy R&D performed in industry. NSF data shows that in 1974, 64% of Federal energy R&D was performed by industry, but by 1979, the industry share had fallen to 38%.

To try to understand this, we have looked at the data for DOE's 12 multiprogram laboratories. Other DOE R&D institutions include 7 Fossil Energy Technology Centers, 4 Physical Research Facilities, 2 Solar Energy Facilities, a Fusion Energy Facility, a Nuclear Energy Engineering Center, and 12 Biomedical and Environmental Facilities. Frankly, Mr. McKelvain and I haven't had the time to look at all of these; however, tables appended to your copy of these remarks indicate that there may be a considerable amount of duplication and overlap in the 12 multiprogram laboratories themselves as well as these 27 other DOE R&D institutions.

Since 1978, the multiprogram labs have increased their non-weapons-related staff from about 34 thousand to about 36 thousand people. The four labs classified by DOE as Weapons Labs increased their non-weapons-related staff by 15%, from about 9,000 to 10,300.

But while the DOE laboratories were growing and diversifying, the buying power of DOE's total budget for the conduct of R&D was shrinking. Between 1978 and 1981, the constant dollar value of the DOE budget for conduct of energy and general sciences R&D dropped by 12%.

The largest single decline in the real dollar R&D budget of DOE was between 1980 and 1981. The total real budget dropped by 10%, but the non-weapons staff of the 12 labs fell by only 1%.

Now, we are faced with a significantly larger reduction in the DOE energy budget for 1982. If past trends continue, a much smaller share of a much smaller resource will remain for performance of R&D in the universities and industry. Is that bad? In my view, it is.

With the anticipated reductions, even the DOE Laboratories must be cut back. As reductions are made, the inherent difficulty in setting priorities on the basis of

technical and economic feasibility will become even more of a problem to the overall DOE program. At the same time, the more severe cutbacks required for work in the universities will result in even greater shortages of the bright young people needed to provide the ideas for tomorrow.

This is not meant to cast aspersions on the many fine people engaged in the energy R&D of the National Laboratories. However, it is only human nature that incentives within such institutions will tend toward the maintenance and healthy growth of their own programs, organizations and employment. There simply is no natural incentive for constant purging of unpromising efforts and transfer of know-how to commercial use as quickly and efficiently as possible.

I have been pleased with the obvious efforts of the DOE and some of the Laboratory Directors to achieve closer interaction between the Labs and industrial research. Some of the Laboratories took the inititative last year to start exploratory talks with members of the Industrial Research Institute. Sessions were held with IRI and Laboratory

representatives, and Dr. George Vineyard of Brookhaven made a special effort by traveling to one of our annual meetings to provide a briefing for the several hundred industry leaders in attendance. And that was a good start.

More recently, Mr. Romatowski, the Acting Undersecretary, recognized the need for a policy framework and distributed guidelines for use of DOE managers in assigning work to the Multiprogram Labs. We have reviewed the criteria and I must admit that a good argument can be made for each element. Unfortunately, writing such guidelines is very difficult. The use of these and similar criteria simply will not be sufficient to produce the needed selectivity.

Using Existing Strengths

The challenge is to devise a framework for the future of these National Laboratories that will continue to give us the advantages of their existing unique technical competences and facilities. We must let them focus their full attention to those areas where special circumstances make it appropriate for them to be directly involved, but at the same time to achieve organizational arrangements and understandings that will permit them to operate in support of -- or as an adjunct to -- private-sector leadership in those technologies that have a commercial objective.

Proposed Action

Now, based on the general philosophy of the government's overall role in energy science and technology discussed earlier, I would like to make the following proposals for specific action.

1. The Department of Energy should adopt the following policies:

   - No further energy centers will be established.

   - All commercially-oriented energy technology development programs that do not have significant participation by industry and/or universities will be phased out by the end of 1982.

   - All programs within 7 years of commercialization must be placed under prime contract (or joint management) with industry beginning in 1983. Joint industry/university participation should be encouraged.

   - DOE energy R&D facilities will be made available to private industry and universities on a reimbursable and proprietary

basis for the conduct of research and experimentation when such work is deemed by the Laboratory and the DOE to be in the national interest.

2. The Secretary of Energy should request the Director of the Office of Science and Technology Policy to appoint a review board comprised of energy industry executives and university research leaders to identify programs in the DOE Laboratories and Centers which should be:

- Cancelled due to lack of technical and/or commercial feasibility,
- Transferred to prime contracts with industry or universities (and, if appropriate, portions which should be subcontracted back to the DOE Labs), or
- Phased out if industrial participation in funding support is not forthcoming.

3. The Review Board also would advise the Secretary on the establishment of guidelines for the use of DOE R&D facilities by private industry and universities and would review and report to the Secretary on the implementation of the policy.

In short, I think it's high time we take a hard look at these laboratories and begin to think about transferring the work and people to the university campuses and industry where we can produce more of the people we need and where the work can be more expeditiously commercialized.

Once again, let me say how much I appreciate this opportunity to present my views. I will do my best to answer your questions in regard to the suggestions I have made or other related matters that may be helpful to you.

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Appendix to Statement of
A. M. Bueche

Energy-Related R&D of 12 DOE Multiprogram Laboratories - 1979

DOE Program Area	DOE Funded* Staff
NON-NUCLEAR ENERGY	3 591
Laboratories	
Argonne	939
Sandia	829
Lawrence Livermore	426
Pacific Northwest	476
Oak Ridge	301
Lawrence Berkeley	209
Los Alamos	204
Brookhaven	178
Ames	32
NUCLEAR ENERGY (FISSION)	8 903
Hanford	2 874
Argonne	2 035
Oak Ridge	1 405
Idaho	1 059
Los Alamos	680
Pacific Northwest	430
Lawrence Livermore	288
Savannah River	132
Basic Energy Sciences (Includes Nuclear Physics)	4 139
Oak Ridge	1 104
Lawrence Berkeley	1 013
Brookhaven	816
Argonne	730
Ames	321
Pacific Northwest	86
Lawrence Livermore	69

* Total staff, average full-time equivalent. Estimated on the basis of information contained in "DOE Research and Development and Field Facilities", DOE/ER 0029, June 1979 and revised data, January 8, 1980.

	STAFF
Fusion Energy	3 478
Lawrence Livermore	1 744
Los Alamos	884
Oak Ridge	452
Lawrence Berkeley	238
Sandia	226
Hanford	89
Brookhaven	71
Environmental, Biomed, Life Sciences	3 235
Brookhaven	675
Oak Ridge	652
Argonne	521
Pacific Northwest	430
Lawrence Berkeley	298
Lawrence Livermore	275
Los Alamos	272
Savannah River	85
Ames	27

Mr. FUQUA. Thank you very much, Art.

Our next witness is Dr. Walter Massey, the director of the Argonne National Laboratory, Argonne, Ill. Dr. Massey, we are happy to have you here representing one of the national labs.

Dr. MASSEY. Thank you very much, Mr. Chairman.

[The biographical sketch of Dr. Massey follows:]

DR. WALTER E. MASSEY

Dr. Massey earned his Bachelor of Science in physics and mathematics in 1958 from Morehouse College, He received his Master of arts and, in 1966, his Ph.D. in physics from Washington University, St. Louis, Missouri.

After a position as post-doctoral research associate at Washington University, he joined the Argonne National Laboratory as a post-doctoral fellow and became a staff physicist in 1968. Later that year, Dr. Massey accepted an assistant professorship of physics at the University of Illinois. He became associate professor at Brown University in 1970. He was promoted to professor of physics and named Dean of the College at Brown in 1975. During his tenure at Brown, he received a number of awards, including the Distinguished Service citation of the American Association of Physics Teachers in 1975. Since July 1979, he has been the Director of Argonne National Laboratory as well as professor of physics at The University of Chicago. He has published widely on the physics of quantum liquids and solids and on the teaching of science and physics.

During his career he has been a member of the Physics Advisory Committee of the National Science Foundation, the Commission on College Physics' Study Group to improve high school and college physics teaching, the American Institute of Physics' Executive Committee on Physics in the Predominatly Black Colleges, the Aspen Center for Physics, and the National Academy of Sciences' Advisory Committee on Eastern Europe and the USSR.

Currently, Dr. Massey is a member of the Advisory Board of the Atlanta University Center Science Research Institute; the Board of Trustees of Washington University; and the Board of Trustees of Brown University. He is also a member of the Council of the American Physical Society, the Board of Directors of the American Association for the Advancement of Science, and the National Science Board.

STATEMENT OF DR. WALTER E. MASSEY, DIRECTOR, ARGONNE NATIONAL LABORATORY, PROFESSOR OF PHYSICS, UNIVERSITY OF CHICAGO

Dr. MASSEY. Madame Chairman and Mr. Chairman, I am pleased to be able to testify this morning. I will summarize my statement briefly and submit the entire document for the record. I tend to write in 50-minute lectures, but I'll be much briefer here.

Mr. FUQUA. We will make the entire document a part of the record. Thank you for summarizing.

Dr. MASSEY. Thank you very much.

I've been associated with Argonne for some time, as a postdoctoral and then as a consultant, but to put my testimony in perspective, you should know I've been laboratory director for only the past 2 years, so my experience in that post is not very extensive. I bring to the lab an experience spent in universities for most of my professional life.

In your letter of invitation, you mentioned some specifics. Since I've addressed those in some detail in my written statement, I won't go into the data and the numbers now.

There are two other issues which I hope will come out and have already been raised. One is to what extent can the research and development activities in the national laboratories contribute to the economic well-being of the Nation; and the second issue is, if this system of national laboratories did not now exist, would it be

in the best interest of the Nation to create this system or a similar one?

I think I would answer in the affirmative to both questions and have tried to present the supporting arguments in this paper.

One very direct mode of interaction between the laboratories and industries and universities is through the management structure itself. All of the multiprogram laboratories are, of course, "GOCO's," or Government-owned, contractor-operated facilities, managed by either universities or industries. So immediately we have one direct method of interaction.

The national needs have changed over the past 30 years and the laboratories have adapted to these new roles and missions, but I believe the great strength of these institutions still lies in the reservoir of scientific and technical talent at the laboratories.

The 12 multi-program labs alone include about one-twelfth of all the employed Ph. D. scientists and engineers doing basic and applied research in this country. Whether they are properly utilized is a subject of this hearing, but they are quite a resource.

The role of the DOE labs with respect to universities and industries has been given a great amount of attention over the past few years. In fact, the Under Secretary has recently issued guidelines establishing criteria for the work at the labs. You have those in your backup material and in my testimony, so I won't go into detail, but I would like to repeat just three items out of that statement.

The guidelines say that the DOE multi-program laboratories should, one, have a role in contributing to energy research and development; two, they should conduct activities in support of the Nation's defense effort; and, three, they should operate and utilize major research facilities and have those available for the university and industry communities.

For roles two and three, there exists no comparable capability in the private sector, so these seem to be well suited to the laboratories.

The operation of large facilities seems to be relatively noncontroversial and accepted by all sectors.

It is within the context of energy research and development that questions are raised about the distribution of effort among the three sectors, the universities, industries and laboratories.

It is inevitable that there will be areas of overlap among these activities. However, the principal focus of these three different types of organizations, I believe, is sufficiently different that one can distinguish among them for the allocation of resources for particular types of research and development.

As Professor Bromley has said, the educational mission of the university uniquely distinguishes it from the other two types of organizations, and the scholarly activities, including research, which take place in universities, ought to be consonant with their educational mission. This implies, then, that certain types of research may be inappropriate to be carried out in universities.

Within our market-oriented society, industries have another role which distinguishes them from universities or national laboratories, and that is the profit motive. A healthy industry in our society is a profitable industry, and to the extent that this is so,

research and development activities undertaken by private industries must sooner or later contribute to their profits.

Certain types of research and development may not be supported by the market at particular times and, therefore, may not be appropriate for performance by the private sector.

For the health of the Nation, then, the Government needs institutions, I believe, to address important questions of research and development which industries or universities cannot and ought not to be asked to address.

Now it might be argued that the Government could fund in industries or at universities the same kind of research and development which takes place at the national laboratories. This could be so to a large extent. However, I do not believe that in the long run this would be healthy for any of the institutions involved or in the best interest of the Nation.

The Federal Government should not distort the primary role of either our educational institutions or our private firms by creating a system which forces or encourages them to engage in kinds of activities inappropriate to their primary mission.

Speaking as a professor and a former dean of a university, I would be reluctant to see universities, through Government funding, become pseudo national laboratories. Nor do I think it is appropriate for Government to replace market forces with Government planning by direct funding of R. & D. for new products and processes in industry.

The Undersecretary has listed a set of criteria which should guide the work being placed in the labs. That's in your backup and in my testimony, so I won't go into it. I think they go a long way in providing the kind of guidance that you are looking for and that the labs need.

Within these guidelines there is adequate room both for cooperation among the laboratories, the universities and industry, and also sufficient definition of particular roles to guide the allocation of Federal funding.

For example, the liquid metal fast breeder reactor program, which is the largest program at Argonne, is an example of an activity which I believe satisfies these guidelines.

The relationships between national labs and industries and universities, are spelled out in some detail in my testimony so I won't repeat them. Professor Bromley has already alluded to many of them. I would just reinforce his statement that since the labs began, the interactions with universities have been strong. In any given year, literally thousands of faculty and students participate in research at all of the national laboratories. These include the weapons laboratories as well as those more directly involved in energy R. & D.

These relationships have various forms, including joint research projects, visiting appointments for scientists who come for up to a year, facililty use by faculty and staff, collaborative research agreements, and subcontracts to university faculty.

Last year, Argonne subcontracted about $7 million to universities. This is not untypical of all of the national laboratories.

The relationship between the national labs and industry has not been as broad based, or long standing as that with universities.

There have been strong interactions with particular industries. Argonne has had extensive interaction with the nuclear industry; the reactor manufacturers and vendors, utilities and the support industries that grew up around the nuclear industry. Dr. Keyworth has mentioned many of the things that grew out of that interaction.

However, as the work of the laboratories has diversified over the past decade, opportunities for strong relationships with a broader base of industrial firms have emerged. The relative newness of some of these activities has legitimately brought the question of industry-laboratory relationships under more scrutiny than that of university-laboratory relationships.

The Department of Energy, recognizing that the labs constitute a tremendous resource, has moved to provide mechanisms allowing for greater interactions with industry. It is clear that the role of a national lab in relation to industry ought to be a place where information and ideas can be fed into the private sector.

As Dr. Lewis Branscomb, chairman of the National Science Board and chief scientist of IBM, has said, and I quote: "Industry, the business community, is the proper place where the assessment of the financial and technical risk involved in bringing a product to commercialization must take place."

Within that context, then, the national laboratories can be supportive and work closely with industry.

I have listed in my written statement, several mechanisms at Argonne by which we cooperate with private industry, ranging all the way from informal joint research projects to more formal industrial participation agreements, to subcontracting, with industry.

The facilities at all of the laboratories are open for use by private industry, of course, just as they are to universities.

The subcommittee is interested in exploring ways to increase interactions between industry and the laboratory. There are two obstacles I have seen since I've been at the lab to this interaction. One is simply the lack of information which industrial scientists have about the facilities available at the labs. We have moved to address this by establishing closer relationships with the Industrial Research Institute, and we've created a task force, which Dr. Bueche has been very instrumental in forming, involving members of IRI and the national laboratories to try to inform the industrial community of what is available at the laboratories.

Another obstacle is again, lack of information concerning the policies on promoting utilization by the private sector of the use of intellectual property developed with public funds.

The choices are either to license on a nonexclusive basis or to grant exclusivity. The problem is that in many cases, both of these could, in principle, be legitimate modes, but it takes a great deal of time to work out individual arrangements with firms and that quite often discourages private industry.

You were interested in the function of program planning and evaluation at the laboratory and the management of the labs. My statement discusses in some detail the method of institutional planning which the Department of Energy has instituted over the last 5 years and explains how that works. The process does, in fact, lead

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to an internal process of self-renewal, and here I'd have to disagree some with my colleague, Professor Bromley.

The role of the managers or the contractors of the laboratory, (in the case of Argonne, the University of Chicago and the Argonne Universities Association—is to see that the laboratory is operated in a manner consistent with this institutional plan which is developed with the Department. The University and the Argonne Universities Association work closely with the local operations office of the Department of Energy.

All Argonne staff are employees of the University of Chicago, and the personnel policies and procedures of the University are followed by the laboratory. A virtue of having laboratories managed by institutions such as the University of Chicago in conjunction with the Argonne Universities Association is that the standard of excellence which prevails at the University is carried over to the laboratory.

The quality of the technical and scientific staff is the primary responsibility of the contracting agent. The Government, I believe wisely, felt in establishing this unique arrangement, the "GOCO," that independent scientific and technical judgment could be gained by having an institution which, though owned by the Federal Government, does not consist of Federal employees, The national laboratories 'role in carrying out programs which are determined by Government policy but, on the other hand, having the need to present independent technical and scientific judgment, has been a good arrangment.

Now this arrangement has, on many occasions in the past, led to differences of opinion and conflicts between laboratory staff and agency staff. I believe this is a healthy phenomenon and is one of the strengths of the laboratory system.

This kind of creative tension helps the government obtain the best possible independent scientific and technical advice on questions of national importance.

To summarize, then, the national laboratories, I believe, do play a key role in the interface between Government, industry, and universities. This role can be enhanced; it probably should be looked at again, as any institution should be investigated from time to time. However, I do believe, to reiterate my second question, that given the current spectrum of activities, their focus on national problems and their ability to draw on and support university and industrial activities in a selective way, that the national laboratories would have to be created if they were not already in place.

Thank you, Mr. Chairman, Madame Chairman.

[The prepared statement of Dr. Massey follows:]

JULY 27, 1981

STATEMENT OF
DR. WALTER E. MASSEY
DIRECTOR, ARGONNE NATIONAL LABORATORY
AND PROFESSOR OF PHYSICS, UNIVERSITY OF CHICAGO
BEFORE THE
SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS
AND THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
JULY 29, 1981

MR. CHAIRMAN, MADAM CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEES, I AM VERY PLEASED TO BE INVITED TO TESTIFY TODAY. THE TOPIC YOU HAVE CHOSEN TO ADDRESS, THE ROLE OF THE NATIONAL LABORATORIES AND THEIR RELATIONSHIPS WITH THE UNIVERSITY RESEARCH COMMUNITY AND WITH PRIVATE INDUSTRY, IS ONE WHICH IS EXTREMELY IMPORTANT. THERE ARE MANY FACETS TO THIS GENERAL ISSUE. I HOPE THIS MORNING WE WILL BE ABLE TO ILLUMINATE SOME OF THE MORE IMPORTANT OF THOSE AND TO PROVIDE THE KIND OF INFORMATION AND DISCUSSION THAT YOU DESIRE.

LET ME SAY A BIT ABOUT MYSELF TO PUT MY TESTIMONY IN PERSPECTIVE. I HAVE BEEN ASSOCIATED WITH ARGONNE NATIONAL LABORATORY FOR SOME TIME - AS A POST-DOCTORAL SCIENTIST FROM 1966 - 1968, AND SUBSEQUENTLY AS A CONSULTANT TO THE LABORATORY FOR ABOUT 10 YEARS. HOWEVER, I HAVE BEEN DIRECTOR OF THE LABORATORY FOR ONLY TWO YEARS, SO MY EXPERIENCE IN THIS

ROLE IS NOT EXTENSIVE. MY VIEW OF THE NATIONAL LABORATORIES IS THAT OF ONE WHO HAS SPENT MOST OF HIS LIFE IN UNIVERSITIES.

IN YOUR LETTER OF INVITATION, YOU MENTIONED SOME SPECIFIC ISSUES WHICH YOU WOULD LIKE THESE HEARINGS TO ADDRESS. I WILL RESPOND TO THOSE DURING MY TESTIMONY, BUT I WOULD ALSO LIKE TO COMMENT ON TWO OTHER ISSUES CONCERNING THE PRESENT ROLES AND FUNCTIONS OF THE NATIONAL LABORATORIES. ONE OF THESE IS WHETHER THE NATIONAL LABORATORIES CAN CONTRIBUTE TO THE WELL-BEING OF THE NATION THROUGH RESEARCH AND DEVELOPMENT (R&D). I BELIEVE THEY CAN, BECAUSE THEY REPRESENT A VAST RESERVOIR OF SCIENTIFIC AND ENGINEERING TALENT AVAILABLE TO THE GOVERNMENT. THE SECOND ISSUE IS, IF THE NATIONAL LABORATORY SYSTEM DID NOT EXIST, WOULD IT BE IN THE BEST INTEREST OF THE NATION TO CREATE IT AT THIS TIME? I BELIEVE THE ANSWER IS YES, FOR REASONS WHICH WILL BECOME CLEAR IN THIS STATEMENT.

THERE ARE ALMOST SIXTY LABORATORIES FOR WHICH THE DEPARTMENT OF ENERGY (DOE) IS RESPONSIBLE. THEY DIFFER IN THEIR FUNCTIONS AND THE WAY IN WHICH THEY ARE MANAGED. TWELVE ARE KNOWN AS MULTIPROGRAM LABORATORIES. INCLUDED AMONG THESE ARE ARGONNE, OAK RIDGE, BROOKHAVEN AND THE THREE WEAPONS LABORATORIES - SANDIA, LIVERMORE, AND LOS ALAMOS. THESE LABORATORIES ARE ALSO KNOWN AS "GOCO'S" OR GOVERNMENT-OWNED, CONTRACTOR-OPERATED FACILITIES. THAT IS, THEY ARE OWNED BY THE GOVERNMENT BUT OPERATED BY EITHER UNIVERSITIES OR PRIVATE INDUSTRIES. THEREFORE, ONE VERY DIRECT MODE OF INTERACTION BETWEEN THE LABORATORIES AND UNIVERSITIES OR INDUSTRIES IS THROUGH THE MANAGEMENT STRUCTURE ITSELF. OAK RIDGE, FOR EXAMPLE, IS OPERATED BY THE NUCLEAR DIVISION OF UNION CARBIDE. THE UNIVERSITY OF CHICAO OPERATES ARGONNE NATIONAL LABORATORY IN CONJUCTION WITH ARGONNE UNIVERSITIES ASSOCIATION (AUA), A CONSORTIUM OF THIRTY MIDWESTERN UNIVERSITIES.

During my two years as Director of Argonne, I have found that the national laboratories are not well understood by many members of the university community and even less so by the industrial sector. Much of this has to do with the origin of the labs. Most of them were spawned by the Manhattan project at the end of World War II. At that time it could probably be said that these laboratories represented the greatest collection of scientific talent, coordinated and focused toward one goal that the world had seen. The personnel were multi-national in origin and educational background and probably represented a substantial percentage of the research scientists and engineers in the U.S. at that time. National needs have changed during the past 30 years, and the laboratories have adapted to new roles and missions, but their great strength and value to the Nation remains their concentration of scientific and technical talent. The twelve multiprogram laboratories now include more than 8600 scientists and 7200 engineers, 6700 of whom hold Ph.D's. The latter figure represents about one-twelfth of employed doctoral-level scientists and engineers engaged in basic and applied research in the U.S. in 1979.

The Role of the National Laboratories.

The role of the DOE multiprogram national laboratories has been a topic to which the Department has given a great deal of attention over the past few years. The Undersecretary of Energy recently issued an excellent description of the functions of the laboratories which addressed the general question of how they should relate to universities and industries. Let me briefly quote from that statement.

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THE DOE MULTI-PROGRAM NATIONAL LABORATORIES PLAY THREE DISTINCT AND VITAL ROLES IN THE NATION'S TECHNOLOGICAL ENTERPRISE: (1) CONTRIBUTING TO ENERGY R&D, (2) CONDUCTING ACTIVITIES IN SUPPORT OF THE NATION'S DEFENSE PROGRAMS INCLUDING SCIENTIFIC AND TECHNICAL SUPPORT OF ALL FACETS OF THE NUCLEAR WEAPONS PROGRAM, AND (3) OPERATION AND UTILIZATION OF MAJOR FACILITIES FOR BASIC RESEARCH IN AREAS SUCH AS HIGH ENERGY PHYSICS, NUCLEAR PHYSICS, AND OTHER PHYSICAL AND BIOLOGICAL SCIENCES AND PROVIDING THE SERVICES OF THESE FACILITIES TO THE NATIONAL RESEARCH COMMUNITY.

FOR ROLES TWO AND THREE, THERE EXISTS NO PARALLEL CAPABILITY IN THE PRIVATE SECTOR. IN ROLE ONE, SEEKING TECHNOLOGICAL SOLUTIONS TO THE NATION'S ENERGY PROBLEMS, THE LABORATORIES MUST OPERATE IN CONCERT WITH UNIVERSITY AND PRIVATE INDUSTRY CAPABILITIES IN THE SAME ARENA.

THE OPERATION AND UTILIZATION OF LARGE FACILITIES IS A FUNCTION CARRIED OUT BY LABS WHICH SEEMS TO BE RELATIVELY NON-CONTROVERSIAL. THIS IS A ROLE THAT IS UNDERSTOOD BY UNIVERSITIES AND THE INDUSTRIAL COMMUNITY AND SEEMS TO BE ONE WHICH IS WELL SUPPORTED. DEFENSE R&D ALSO APPEARS TO BE ACCEPTED BY ALL AS A LEGITIMATE FUNCTION OF THE GOVERNMENT WHICH SHOULD BE CARRIED OUT IN THE NATIONAL LABORATORIES.

IT IS WITHIN THE CONTEXT OF ENERGY R&D THAT QUESTIONS ARE RAISED ABOUT THE RELATIVE DISTRIBUTION OF EFFORT AMONG THESE THREE SECTORS. LET ME ADDRESS THIS ISSUE. BECAUSE OF THE NATURE OF THESE INSTITUTIONS - UNIVERSITIES, INDUSTRIES AND NATIONAL LABORATORIES - IT IS INEVITABLE THAT THERE WILL

BE AREAS OF OVERLAP AMONG THE ACTIVITIES. HOWEVER, THE PRINCIPAL FOCUS OF THESE THREE DIFFERENT TYPES OF ORGANIZATIONS IS SUFFICIENTLY DIFFERENT THAT ONE CAN DISTINGUISH AMONG THEM FOR THE ALLOCATION OF RESOURCES FOR PARTICULAR TYPES OF RESEARCH AND DEVELOPMENT.

THE EDUCATIONAL MISSION OF THE UNIVERSITY UNIQUELY DISTINGUISHES IT FROM THE OTHER TWO TYPES OF ORGANIZATIONS AND THE SCHOLARLY ACTIVITIES, INCLUDING RESEARCH, WHICH TAKE PLACE IN UNIVERSITIES OUGHT TO BE CONSONANT WITH THEIR EDUCATIONAL MISSION. THIS IMPLIES THAT CERTAIN TYPES OF RESEARCH MAY BE INAPPROPRIATE TO BE CARRIED OUT AT UNIVERSITIES.

WITHIN OUR MARKET-ORIENTED SOCIETY, INDUSTRIES HAVE ANOTHER ROLE WHICH DISTINGUISHES THEM FROM UNIVERSITIES OR NATIONAL LABORATORIES, THE PROFIT MOTIVE. A HEALTHY INDUSTRY IN OUR SOCIETY IS A PROFITABLE INDUSTRY. TO THE EXTENT THAT THIS IS SO, RESEARCH AND DEVELOPMENT ACTIVITIES UNDERTAKEN BY INDUSTRIES MUST CONTRIBUTE SOONER OR LATER TO THEIR PROFITS. CERTAIN TYPES OF RESEARCH AND DEVELOPMENT MAY NOT BE SUPPORTED BY THE MARKET AT PARTICULAR TIMES AND THEREFORE, MAY NOT BE APPROPRIATE FOR PERFORMANCE BY THE PRIVATE SECTOR.

FOR THE HEALTH OF THE NATION, THEN, THE GOVERNMENT NEEDS INSTITUTIONS TO ADDRESS IMPORTANT QUESTIONS OF RESEARCH AND DEVELOPMENT WHICH INDUSTRIES OR UNIVERSITIES CANNOT OR OUGHT NOT TO ADDRESS. IT MIGHT BE ARGUED THAT THE GOVERNMENT COULD FUND AT UNIVERSITIES OR IN INDUSTRY THE SAME KIND OF RESEARCH AND DEVELOPMENT WHICH TAKES PLACE AT NATIONAL LABORATORIES. I DO NOT BELIEVE THIS WOULD BE HEALTHY FOR ANY OF THE INSTITUTIONS OR THE NATION IN THE LONG RUN. THE FEDERAL GOVERNMENT SHOULD NOT DISTORT THE PRIMARY ROLE OF EITHER OUR EDUCATIONAL INSTITUTIONS OR OUR PRIVATE FIRMS

BY CREATING A SYSTEM WHICH FORCES OR ENCOURAGES THEM TO ENGAGE IN KINDS OF ACTIVITIES INAPPROPRIATE TO THEIR PRIMARY MISSION. SPEAKING AS A PROFESSOR AND FORMER DEAN, I WOULD BE RELUCTANT TO SEE UNIVERSITIES, THROUGH GOVERNMENT FUNDING, BECOME PSEUDO-NATIONAL LABORATORIES. NOR DO I THINK IT APPROPRIATE FOR GOVERNMENT TO REPLACE MARKET FORCES WITH GOVERNMENT PLANNING BY DIRECT FUNDING OF R&D FOR NEW PRODUCTS AND PROCESSES.

ENERGY RESEARCH AND DEVELOPMENT PURSUED AT THE NATIONAL LABORATORIES OUGHT TO MEET SOME OF THE FOLLOWING CHARACTERISTICS:

.....IT SHOULD BE RESEARCH AND DEVELOPMENT OF A LONG-RANGE, HIGH-RISK, POTENTIALLY HIGH PAYOFF, NATURE FOR WHICH NEAR TERM ECONOMIC PAYOFF IS MINIMAL AND, THEREFORE, THERE IS LITTLE INCENTIVE FOR PRIVATE SUPPORT;

.....IT SHOULD ADDRESS QUESTIONS OF ENERGY TECHNOLOGIES WHICH HAVE NATIONAL OR TRANSNATIONAL CONSEQUENCES SUCH AS LARGE SCALE HEALTH AND ENVIRONMENTAL PROBLEMS;

.....IT SHOULD REQUIRE THE USE OF FACILITIES, EITHER TOO LARGE OR COMPLEX TO BE OPERATED BY A SINGLE UNIVERSITY OR INDUSTRY OR SUFFICIENTLY UNIQUE THAT FEDERAL FUNDING IS APPROPRIATE FOR THEIR SUPPORT;

.....IT SHOULD INVOLVE INTERNATIONAL ISSUES WHERE THE ROLE OF THE FEDERAL GOVERNMENT IS CLEARLY DEFINED SUCH AS AREAS OF NATIONAL SECURITY AND ISSUES SUCH AS NUCLEAR NON-PROLIFERATION.

WITHIN THESE GUIDELINES, THERE IS ADEQUATE ROOM BOTH FOR COOPERATION AMONG LABORATORIES, UNIVERSITIES AND INDUSTRY, AND ALSO SUFFICIENT DEFINITION OF PARTICULAR ROLES TO GUIDE THE ALLOCATION OF FEDERAL FUNDING. THE LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM, WHICH IS THE LARGEST SINGLE PROGRAM AT ARGONNE, IS AN EXAMPLE OF AN ACTIVITY WHICH SATISFIES THESE GUIDELINES, AS WELL AS PROVIDING FOR HEALTHY UNIVERSITY AND INDUSTRIAL INTERACTIONS.

RELATIONS BETWEEN NATIONAL LABORATORIES AND THE UNIVERSITIES

THE NATIONAL LABORATORIES HAVE HAD STRONG INTERACTIONS WITH THE UNIVERSITY COMMUNITY SINCE THEIR BEGINNINGS, AND THEY CONTINUE TO PROVIDE A RANGE OF UNIQUE CAPABILITIES TO UNIVERSITY FACULTY AND STUDENTS. MOST OF THESE TEND TO FOCUS ON THE OPERATION OF MAJOR RESEARCH FACILITIES NEEDED BY UNIVERSITY SCIENTISTS BUT UNSUITABLE FOR CAMPUSES.

GROWING IN IMPORTANCE OVER THE LAST FEW YEARS, HAS BEEN THE EMERGENCE OF THE LABS AS A SETTING FOR MOUNTING MULTI-DISCIPLINARY RESEARCH ON PROBLEMS THAT CROSS THE CLASSICAL LINES OF INVESTIGATION AND INVOLVE LABORATORY STAFF, VISITING UNIVERSITY SCIENTISTS AND INDUSTRIAL SCIENTISTS WHO COME TOGETHER FROM ACROSS THE NATION. FOR EXAMPLE, IN 1979 AND 1980, THE AUTHORSHIP OF MORE THAN 60 PERCENT OF THE PUBLICATIONS OF SCIENTISTS AT NATIONAL LABS WAS IN COOPERATION WITH SCIENTISTS FROM OTHER ORGANIZATIONS, PRIMARILY UNIVERSITIES BUT MANY ALSO FROM INDUSTRY. ENGAGING IN THIS COOPERATIVE RESEARCH FACULTY MEMBERS AND STUDENTS AID THE LABORATORY IN FULFILLING ITS MISSION BUT THEY ALSO GAIN ACCESS TO INFORMATION, TECHNIQUES AND VIEWPOINTS THAT HELP THEM TO MAKE THEIR OWN CONTRIBUTIONS TO SCIENCE AND TECHNOLOGY. IT CAN SAFELY BE SAID THAT VIRTUALLY ALL OF THE NATION'S HIGH-ENERGY PHYSICISTS, NUCLEAR PHYSICISTS AND REACTOR

ENGINEERS AS WELL AS A SUBSTANTIAL FRACTION OF ITS MATERIALS SCIENTISTS, CHEMISTS, AND BIOLOGISTS, HAVE HAD PRODUCTIVE INVOLVEMENT WITH THE NATIONAL LABORATORIES EITHER DIRECTLY OR THROUGH STUDENT-FACULTY RELATIONSHIPS.

THERE IS NO DOCUMENT THAT DEALS WITH THE FULL SCOPE AND INTENSITY OF THE INTERACTIONS BETWEEN THE UNIVERSITIES AND THE NATIONAL LABORATORIES. SUCH A DOCUMENT, IF IT EXISTED, WOULD ADD MUCH TO THIS TESTIMONY. IN ITS ABSENCE, I WILL OF NECESSITY DRAW ON SOME OBSERVATIONS FROM ARGONNE, ADDING IMPORTANT EXAMPLES FROM SEVERAL OF THE OTHER LABORATORIES. EACH LABORATORY HAS DEVELOPED WAYS OF INTERACTING EFFECTIVELY WITH THE UNIVERSITY COMMUNITY THAT FIT ITS OWN STYLE AND MISSION, BUT THERE ARE MANY ELEMENTS OF CONSISTENCY THAT CAN SERVE AS A FRAMEWORK FOR THIS DISCUSSION. MOST OF THE LABORATORIES HAVE A UNIT DEVOTED EXCLUSIVELY TO NURTURING, PROMOTING AND ADMINISTERING UNIVERSITY-LABORATORY INTERACTIONS. FOR EXAMPLE, AT ARGONNE, THE DIVISION OF EDUCATIONAL PROGRAMS HAS THIS RESPONSIBILITY. THE ACTIVITIES CARRIED OUT BY THE DIVISION ARE FUNDED BOTH FROM LABORATORY OVERHEAD AND BY DIRECT PROGRAMMATIC FUNDING FROM THE DEPARTMENT OF ENERGY. THIS IS TYPICAL OF ALL THE LABORATORIES.

THE ACTIVITIES CAN BE ORGANIZED INTO FOUR CATEGORIES. THE FIRST IS VISITING APPOINTMENTS FOR BOTH FACULTY AND STUDENTS. THE NUMBER OF PEOPLE INVOLVED IS SUBSTANTIAL. IN FY 1980, FOR EXAMPLE, OAK RIDGE AND ARGONNE EACH HAD ABOUT 1200 SUCH APPOINTMENTS. IN A TYPICAL YEAR, BROOKHAVEN HAS VISITING APPOINTMENTS FOR CLOSE TO 1000 ACADEMIC SCIENTISTS FROM 200 COLLEGES AND UNIVERSITIES. LAWRENCE LIVERMORE INVOLVES APPROXIMATELY 350 FACULTY MEMBERS IN A SIMILAR PERIOD. LAWRENCE BERKELEY, EMPHASIZING ANOTHER MODE, HAS ABOUT 160 MEMBERS OF ITS SCIENTIFIC STAFF WHO HOLD JOINT APPOINTMENTS

AT THE UNIVERSITY OF CALIFORNIA, AND OVER 500 PH.D STUDENTS IN RESIDENCE AT ANY GIVEN TIME.

IT WOULD BE DIFFICULT TO OVERSTATE THE VALUE TO BOTH THE LABORATORIES AND THE UNIVERSITY COMMUNITY OF THE STIMULATION THAT RESULTS FROM THESE APPOINTMENTS. MOREOVER, THESE APPOINTMENTS INVOLVE MANY OF THE BEST ESTABLISHED AND DEVELOPING SCIENTIFIC AND ENGINEERING MINDS IN THE NATION IN THE EFFORTS TO SOLVE THE ENERGY PROBLEM. RESEARCH PARTICIPATION AND THESIS RESEARCH OPPORTUNITIES ARE CRUCIAL ELEMENTS IN THE DEPARTMENT OF ENERGY'S EFFORT TO ASSURE THE AVAILABILITY OF TRAINED MANPOWER FOR THIS TASK IN FUTURE YEARS.

THE SECOND MAJOR CATEGORY OF LABORATORY-UNIVERSITY INTERACTION INVOLVES THE USE OF FACILITIES BY FACULTY AND STUDENTS. THESE FACILITIES INCLUDE MAJOR INSTRUMENTS, SUCH AS ACCELERATORS, DESIGNED FOR USE BY INDEPENDENT UNIVERSITY GROUPS. THE LABORATORIES PROVIDE THE NECESSARY SUPPORT AND OPERATING CREWS. WE HAVE ABOUT A DOZEN SUCH FACILITIES AT ARGONNE, AND IN FY 1980 HAD OVER 80 USER GROUPS CARRYING OUT EXPERIMENTS ON THEM. I MIGHT ADD THAT WE ARE ABOUT TO BEGIN OPERATION OF A NEW USER FACILITY, THE INTENSE PULSED NEUTRON SOURCE, AND THERE IS A GREAT DEAL OF INTEREST IN IT IN THE ACADEMIC COMMUNITY. WE HAVE 120 PROPOSALS FOR EXPERIMENTAL WORK ON THIS DEVICE FOR NEXT YEAR ALONE, FAR IN EXCESS OF WHAT WE COULD ACCOMMODATE IF WE COULD RUN THE DEVICE 24 HOURS A DAY ALL YEAR. OTHER LABORATORIES HAVE SIMILAR OPERATIONS. OAK RIDGE NATIONAL LABORATORY, FOR INSTANCE, OFFERS ACCESS TO NINE MAJOR USER FACILITIES AND HAS RECENTLY FORMALIZED THEIR USE TO ALLOCATE TIME MORE SYSTEMATICALLY AND SET PRIORITIES AMONG USERS.

THE NATIONAL LABORATORIES HOST A LARGE NUMBER OF UNIVERSITY FACULTY AT CONFERENCES, SHORT COURSES, WORKSHOPS, AND SEMINARS.

DURING 1980 OVER 1200 FACULTY CAME TO ARGONNE FOR SUCH EVENTS LASTING FROM A DAY TO A FULL WEEK. THESE ACTIVITIES ARE DESIGNED TO PROVIDE THE PARTICIPANTS WITH COMPLETE INFORMATION ON THE LATEST DEVELOPMENTS IN THEIR RESPECTIVE FIELDS AND FORM THE THIRD MAJOR CATEGORY OF LABORATORY-UNIVERSITY INTERACTIONS. THIS IS, OF COURSE, A VERY IMPORTANT MODE OF SCIENTIFIC EXCHANGE.

FINALLY, THE NATIONAL LABORATORIES INVOLVE UNIVERSITY SCIENTISTS AND ENGINEERS IN RESEARCH THROUGH FORMAL CONTRACTUAL AGREEMENTS. THE AMOUNT SUBCONTRACTED CAN VARY SIGNIFICANTLY FROM YEAR TO YEAR DEPENDING ON CIRCUMSTANCES. AT ARGONNE IT IS TYPICALLY BETWEEN FOUR AND SEVEN MILLION DOLLARS A YEAR. OTHER LABORATORIES ENGAGE IN THIS FOURTH INTERACTION MODE AT COMMENSURATE LEVELS.

I BELIEVE THAT THE INFORMATION ABOVE IS ITSELF A STRONG INDICATION OF THE SUCCESS OF THE RELATIONSHIP THAT EXISTS BETWEEN UNIVERSITIES AND NATIONAL LABORATORIES. ANOTHER UNAMBIGIOUS WAY TO MEASURE THE VALIDITY OF THIS RELATIONSHIP, AS IT APPEARS TO THE NATIONAL LABORATORIES, IS TO SEE IF OTHERS VIEW IT IN THE SAME WAY. IN SEEKING AN EXTERNAL PERSPECTIVE I GO BACK TO A STATEMENT IN THE EXTENSIVE REPORT OF THE PHYSICS SURVEY COMMITTEE OF THE NATIONAL ACADEMY OF SCIENCES, PREPARED SOME YEARS AGO UNDER THE CHAIRMANSHIP OF PROFESSOR D. ALLAN BROMLEY OF YALE UNIVERSITY, WHO IS ALSO GIVING TESTIMONY TODAY. ADDRESSING THE ROLE OF THE NATIONAL LABORATORIES, THE REPORT SAYS IN PART:

> THE FUNCTION OF THE NATIONAL LABORATORIES IN THE CASE OF A MAJOR PIECE OF SCIENTIFIC INSTRUMENTATION TOO LARGE TO FIT COMFORTABLY, EITHER PHYSICALLY OR ADMINISTRATIVELY, ON A UNIVERSITY CAMPUS - SUCH AS A SUPER-ACCELERATOR - IS OBVIOUS. THERE ARE, HOWEVER, MANY OTHER UNIQUE CHARACTERISTICS OF THESE

INSTITUTIONS. SOME AREAS OF SCIENCE, PARTICULARLY THOSE OF AN INTERDISCIPLINARY CHARACTER CAN BE PURSUED EFFECTIVELY ONLY WITHIN SUCH A FRAMEWORK.

. . .ALL THESE LABORATORIES FULFILL MULTIPLE PURPOSES IN VARYING MIXES. THESE PURPOSES ARE:

1. PROVIDING SPECIAL FACILITIES FOR THE USE OF THE SCIENTIFIC COMMUNITY AT LARGE;
2. CONDUCTING IN-HOUSE AND COLLABORATIVE RESEARCH AND DEVELOPMENT PROGRAMS WITH THEIR OWN FACILITIES TO ENSURE A CORE OF EXPERTS RESIDENT AT THE FACILITIES FOR THEIR NURTURE AND ADVANCEMENT AND TO MAXIMIZE THEIR USE, INCLUDING FULL EXPLOITATION, WHICH WOULD NOT BE READILY ACHIEVED BY VISITING USERS ALONE;
3. CONDUCTING RESEARCH AND DEVELOPMENT PROGRAMS OF DIRECT MISSION INTEREST TO THE SPONSORING AGENCY, AND SOMETIMES TO OTHER AGENCIES, WHICH MAY OR MAY NOT BE DIRECTLY RELATED TO THE SPECIAL FACILITIES FOR REGIONAL OR NATIONAL USE;
4. PROVIDING A CORE OF EXPERTS FOR DIVERSE TECHNICAL ADVICE AND ASSISTANCE TO THE SPONSORING AGENCY AND SOMETIMES TO OTHER AGENCIES;
5. CONDUCTING TRAINING AND INFORMATION DISSEMINATION PROGRAMS OF INTEREST TO THE SPONSORING AGENCY OR OF IMPORTANCE TO THE HEALTH OF SCIENCE MORE GENERALLY;
6. CONCEIVING, DESIGNING, AND BUILDING NEW AND MORE ADVANCED FACILITIES FOR REGIONAL OR NATIONAL USE AS NEEDS AND OPPORTUNITIES ARISE.

THESE ARE STATEMENTS OF PURPOSE, MADE BY AN INFORMED EXTERNAL GROUP WITH LARGE UNIVERSITY REPRESENTATION, THAT COINCIDE CLOSELY WITH THE NATIONAL LABORATORIES' OWN VIEW OF THEIR ROLE.

NO GENUINELY ACTIVE RELATIONSHIP CAN EXIST FOR THIRTY-FIVE YEARS WITHOUT SOME PROBLEMS ARISING. THE RELATIONSHIP BETWEEN THE UNIVERSITIES AND THE NATIONAL LABORATORIES HAS NOT BEEN AN EXCEPTION. I WILL IDENTIFY TWO THAT SEEM TO NEED FURTHER ATTENTION.

THE FIRST IS THE LACK OF FULL AWARENESS ON THE CAMPUS OF THE RANGE OF RESEARCH CAPABILITIES THAT EXIST AT THE NATIONAL LABORATORIES AND THE CONDITIONS UNDER WHICH THEY CAN BE UTILIZED BY FACULTY MEMBERS AND STUDENTS. THE NATIONAL LABORATORIES AND THEIR CONTRACTORS ARE NOW DEVELOPING MORE SYSTEMATIC WAYS TO PROVIDE THE RELEVANT FACTS TO THE CAMPUS. AS AN EXAMPLE, I AM APPENDING AN EXCERPT FROM THE 1981 ANNUAL REPORT OF THE ARGONNE UNIVERSITIES ASSOCIATION WHICH, UNDER THE HEADING "ACCESS TO ARGONNE", DESCRIBES THE RANGE OF ARGONNE USER FACILITIES AND FACILITIES FOR COLLABORATIVE RESEARCH THAT ARE AVAILABLE FOR USE BY THE SCIENTIFIC COMMUNITY. THIS MATERIAL IS BEING GIVEN WIDE CIRCULATION. YOU WILL NOTE THAT IN THE CASE OF THE LARGE USER-DEDICATED FACILITIES, ARGONNE ASSESSES NO CHARGES TO RECOVER OPERATING COSTS, PROVIDED THAT THE RESEARCH IS RELEVANT TO DOE INTERESTS. PROGRAM COMMITTEES WITH WIDE NATIONAL REPRESENTATION SELECT THE EXPERIMENTS ON GROUNDS OF SCIENTIFIC MERIT AND THE RESULTS ARE PUBLISHED IN THE OPEN LITERATURE.

THERE IS ALSO ANOTHER CLASS OF FACILITIES SUPPORTED BY DOE FUNDS TO CONDUCT SPECIFIC LABORATORY WORK, TO WHICH EXTERNAL USERS HAVE ACCESS ON A TIME-AVAILABLE BASIS AND FOR WHICH SOME SHARE OF THE OPERATING COSTS MAY BE CHARGED. BEFORE LEAVING THIS POINT I WANT TO SHARE WITH YOU A GROWING CONCERN OF THE DIRECTORS OF THE NATIONAL LABORATORIES REGARDING THE MAJOR USER-DEDICATED FACILITIES. AS CAMPUS AWARENESS OF THESE CAPABILITIES EXPANDS AND AS DEMANDS FOR USE GROW, IT WILL BE INCREASINGLY DIFFICULT FOR THE LABORATORIES TO PROVIDE ENOUGH RUNNING TIME TO SATISFY THE NEEDS OF OUR UNIVERSITY COLLEAGUES

BECAUSE MANY, IF NOT MOST, OF THESE FACILITIES ARE CURRENTLY FUNDED FOR ONLY A FRACTION OF A FULL YEAR'S OPERATION. THIS LIMITED FUNDING HAS COME ABOUT BECAUSE OF INFLATION, INCREASED POWER COSTS, AND BUDGETARY CONSTRAINTS.

A SECOND PROBLEM, WHICH CAN BE IDENTIFIED IN LARGE PART AS A COMMUNICATION PROBLEM, IS A LACK OF FULL UNDERSTANDING BY THE COMMUNITY OF UNIVERSITY-BASED SCIENTISTS AND ENGINEERS AND BY THEIR COLLEAGUES AT THE NATIONAL LABORATORIES OF THE COMPETITIVE PROCESS BY WHICH EACH ACQUIRES AND RETAINS SUPPORT. I KNOW THAT MANY NATIONAL LABORATORY SCIENTISTS AND ENGINEERS ARE STILL NOT FULLY AWARE OF THE INTENSIVE AND DETAILED PROPOSAL PREPARATION AND PEER REVIEW THAT ARE REQUIRED OF UNIVERSITY FACULTY MEMBERS IN ORDER FOR THEM TO JUSTIFY SUPPORT. I AM ALSO SURE THAT MANY FACULTY MEMBERS ARE NOT FULLY AWARE OF THE EXTENSIVE, SYSTEMATIC REVIEW OF THE SCIENTIFIC AND TECHNICAL ACTIVITIES AT THE NATIONAL LABORATORIES. THESE LATTER REVIEWS ARE PERFORMED IN PART BY AD HOC TEAMS APPOINTED BY THE LABORATORY DIRECTOR, IN PART BY TEAMS SPECIFICALLY CHARTERED BY THE DEPARTMENT OF ENERGY, AND IN PART BY STANDING VISITING COMMITTEES OF SCIENTIFIC PEERS WITH ROTATING NATIONAL REPRESENTATION, WHICH ARE INDEPENDENTLY CHARTERED BY THE LABORATORY CONTRACTOR. EXTERNAL SCIENTIFIC BODIES WHICH HAVE EXAMINED THE REVIEW SYSTEM IN USE AT THE NATIONAL LABORATORIES HAVE GIVEN IT GOOD MARKS. I QUOTE AGAIN FROM THE REPORT OF THE PHYSICS SURVEY COMMITTEE.

> THE PHYSICS SURVEY COMMITTEE BELIEVES THAT THE SYSTEM OF REVIEWS OF PROGRAMS HAS WORKED WELL, WITH NO MORE OVERLAP THAN ANY SCIENCE NEEDS FOR NORMAL VERIFICATION. THIS SYSTEM HAS FOSTERED VIGOROUS SCIENTIFIC RESEARCH FOR THE NATIONAL BENEFIT AND HAS STIMULATED THE WORK OF BOTH NATIONAL LABORATORY AND UNIVERSITY-BASED SCIENTISTS.

THERE REMAINS A NEED TO MAKE THE REVIEW PROCESSES ON THE CAMPUSES AND AT THE NATIONAL LABORATORIES MORE VISIBLE AND BETTER UNDERSTOOD BY PROFESSORS AND LABORATORY SCIENTISTS.

RELATIONSHIPS BETWEEN NATIONAL LABORATORIES AND INDUSTRY.

HISTORICALLY, THE LABORATORIES HAVE NOT HAD THE KIND OF BROAD-BASED RELATIONSHIPS WITH PRIVATE INDUSTRY THAT THEY HAVE HAD WITH THE UNIVERSITIES. THERE HAVE BEEN VERY STRONG INTERACTIONS WITH PARTICULAR INDUSTRIES, OF WHICH THE NUCLEAR INDUSTRY IS THE MOST PROMINENT. ARGONNE'S MAJOR ROLE HISTORICALLY HAS BEEN IN REACTOR RESEARCH AND DEVELOPMENT. PRACTICALLY EVERY TYPE OF REACTOR NOW OPERATING CAN BE TRACED IN ONE WAY OR ANOTHER TO RESEARCH AND DESIGN DONE BY ARGONNE SCIENTISTS. THERE HAS ALWAYS BEEN A STRONG RELATIONSHIP BETWEEN THE REACTOR MANUFACTURERS AND VENDORS, AND THE UTILITIES AND THE LABORATORY. THIS HAS ALSO BEEN TRUE FOR OAK RIDGE.

HOWEVER, AS THE WORK AT THE LABORATORIES HAS DIVERSIFIED OVER THE PAST DECADE, OPPORTUNITIES FOR STRONG RELATIONSHIPS WITH A BROADER BASE OF INDUSTRIAL FIRMS HAVE EMERGED. THE RELATIVE NEWNESS OF SOME OF THESE ACTIVITIES HAS LEGITIMATELY BROUGHT THE QUESTION OF INDUSTRY-LABORATORY RELATIONSHIPS UNDER MORE SCRUTINY THAN THAT OF UNIVERSITY-LABORATORY RELATIONSHIPS. THE DEPARTMENT OF ENERGY, RECOGNIZING THAT THE LABORATORIES CONSTITUTE A TREMENDOUS RESOURCE FOR COOPERATIVE VENTURES WITH PRIVATE INDUSTRY WHICH CAN MUTUALLY BENEFIT BOTH, HAS MOVED TO ESTABLISH POLICIES TO ENCOURAGE THIS. IT IS CLEAR THAT THE ROLE OF A NATIONAL LABORATORY IN RELATION TO INDUSTRY SHOULD BE THAT OF A SOURCE OF INFORMATION AND IDEAS. THE LABORATORIES CONDUCT RESEARCH THAT EXPAND AN ENTIRE BASE OF TECHNOLOGY AND PERFORM ENGINEERING DEVELOPMENT ON HIGH-RISK ENERGY TECHNOLOGIES. THIS RESEARCH OUGHT TO BE CARRIED ONLY TO THAT POINT WHERE TECHNICAL AND ECONOMIC FEASIBILITY IS DEMONSTRATED. THE PRESENT ADMINISTRATION HAS

ESTABLISHED A POLICY THAT THE ROLE OF THE FEDERAL GOVERNMENT, INCLUDING THE NATIONAL LABORATORIES, IN MOUNTING LARGE-SCALE DEMONSTRATION PROJECTS OUGHT TO BE MINIMAL AND SHOULD IN NO CASE GO BEYOND THE POINT WHERE IT IS LEGITIMATE FOR PRIVATE INDUSTRY TO BE INVOLVED. THERE IS OF COURSE NO EXACT POINT WHERE DEVELOPMENT ENDS AND DEMONSTRATION BEGINS. BUT THE PRINCIPLE IS NEVERTHELESS VALID.

AS DR. LEWIS M. BRANSCOMB, CHAIRMAN OF THE NATIONAL SCIENCE BOARD AND CHIEF SCIENTIST OF IBM, HAS SAID, "INDUSTRY -- THE BUSINESS COMMUNITY -- IS THE PROPER PLACE WHERE THE ASSESSMENT OF THE FINANCIAL AND TECHNICAL RISK INVOLVED IN BRINGING A PRODUCT TO COMMERCIALIZATION MUST TAKE PLACE." THE RELATIVE ROLES OF THE NATIONAL LABORATORIES AND INDUSTRY, I BELIEVE, ARE CLEAR, ALTHOUGH THERE WILL ALWAYS BE SOME AMBIGUITY AS TO WHERE THE FEDERAL GOVERNMENT'S ROLE SHOULD END AND INDUSTRY'S ROLE SHOULD BEGIN.

THERE ARE SEVERAL MECHANISMS BY WHICH THE LABORATORIES AND INDUSTRIES COOPERATE JOINTLY TO CARRY OUT RESEARCH AND DEVELOPMENT. LET ME MENTION A FEW OF THOSE USED AT ARGONNE.

COLLABORATIVE RESEARCH ACTIVITIES ARE GENERALLY UNDERTAKEN WITHOUT FORMAL AGREEMENTS OR A CONTRACT. SCIENTISTS FROM BOTH INSTITUTIONS COOPERATE ON RESEARCH WHICH IS THEN PUBLISHED IN THE OPEN LITERATURE. AN EXAMPLE OF THIS IS THE RESEARCH THAT ARGONNE AND THE UPJOHN COMPANY ARE DOING TO UTILIZE THE TWO-DIMENSIONAL ELECTROPHORESIS INSTRUMENTATION WHICH WAS DEVELOPED IN THE BIOLOGICAL AND MEDICAL RESEARCH DIVISION AT ARGONNE. THERE IS ALSO JOINT WORK BETWEEN CHEMISTS AT ARGONNE AND AT DUPONT TO CARRY OUT NEUTRON DIFFRACTION STUDIES OF CATALYSTS, AND COLLABORATION BETWEEN SCIENTISTS AT BELL LABORATORIES AND OUR SOLID STATE SCIENTISTS TO DO X-RAY AND NEUTRON DIFFRACTION STUDIES OF NEW ORGANIC SUPER-CONDUCTORS. EXAMPLES OF THIS TYPE ABOUND AND ARE COMMON AT ALL OF THE LABORATORIES.

A MORE FORMAL TYPE OF ARRANGEMENT IS THROUGH INDUSTRIAL PARTICIPATION AGREEMENTS. THESE ARE FORMAL CONTRACTS, FLEXIBLE IN THEIR TERMS, INVOLVING IN MOST CASES AN INDIVIDUAL OR TEAM FROM A PRIVATE INDUSTRY COMING TO THE LABORATORY TO WORK FOR A FEW MONTHS TO A YEAR. THE FIRM PAYS THE COMPLETE COST OR SHARES COST OF THE WORK WITH THE LABORATORY. THESE AGREEMENTS HAVE BEEN USED IN ALL OF ARGONNE'S PROGRAMS IN BOTH BASIC RESEARCH AND DEVELOPMENT ACTIVITIES. THE LABORATORY GAINS FROM THE EFFORT AND IDEAS OF EXPERIENCED INDUSTRIAL SCIENTISTS AND ENGINEERS. INDUSTRY GETS FIRST-HAND EXPERIENCE AND AN OPPORTUNITY TO ASSESS A DEVELOPING TECHNOLOGY NOT READY FOR THE MARKETPLACE. THE INDUSTRIAL PARTICIPANTS GO TO THEIR FIRMS REGULARLY TO REPORT ON ACTIVITIES AND THEN RETURN TO THE LABORATORY TO CONTINUE THE WORK.

WE HAVE HAD SUCH AGREEMENTS WITH A NUMBER OF COMPANIES, INCLUDING EXXON, DOW, BURNS AND ROE, ROCKWELL INTERNATIONAL, RCA, AND MAJOR BATTERY MANUFACTURERS.

THE LABORATORIES ALSO INTERACT WITH INDUSTRIES THROUGH SUBCONTRACTS FOR RESEARCH AND DEVELOPMENT. THESE SUBCONTRACTS PROVIDE THE DEVELOPMENT OF A MANUFACTURING AND FABRICATION CAPABILITY IN INDUSTRIES AND ALLOW ESTABLISHMENT OF COST AND TECHNICAL FEASIBILITIES FOR RESEARCH PRODUCTS WHICH WILL EMERGE FROM THE LABORATORY. OVER THE PAST FEW YEARS, WE HAVE AWARDED SUBCONTRACTS FOR THE DEVELOPMENT OF ADVANCED BATTERIES, SOLAR COLLECTORS, COMPONENTS FOR NUCLEAR REACTORS, AND INSTRUMENTATION FOR MEASURING AND TESTING FOSSIL ENERGY PLANTS.

CERTAIN FACILITIES AT THE LABORATORIES ARE OF PARTICULAR INTEREST TO INDUSTRIAL SCIENTISTS AND ENGINEERS AND THESE ARE AVAILABLE FOR THEIR USE. AT ARGONNE THERE IS THE INTENSE PULSED NEUTRON SOURCE WHICH PROVIDES HIGH INTENSITY NEUTRONS FOR MATERIALS STUDIES; AND TEST REACTORS SUCH AS THE EXPERIMENTAL

BREEDER REACTOR-II (EBR-II), AND THE TRANSIENT REACTOR TEST FACILITY (TREAT). THERE IS ONE HIGH VOLTAGE ELECTRON MICROSCOPE AT ARGONNE AND ANOTHER AT LAWRENCE BERKELEY LABORATORY. THE SYNCHROTRON LIGHT SOURCE AT BROOKHAVEN AND THE SMALL ANGLE NEUTRON SCATTERING FACILITY AT OAK RIDGE ARE OTHER SUCH FACILITIES.

INDUSTRIAL USERS MAY USE SOME OF THESE FACILITIES FOR PROPRIETARY WORK. IN THESE INSTANCES THE FULL COST FOR THE USE OF THE FACILITY IS PAID. TYPICALLY, FOR UNIVERSITIES AND INDUSTRIES, THERE IS NO FEE FOR FACILITY USE WHEN THE RESULTS ARE TO BE PUBLISHED IN THE OPEN LITERATURE.

STILL ANOTHER KIND OF INTERACTION I SHOULD MENTION IS THE EXCHANGE OF INFORMATION AMONG INDUSTRIAL AND LABORATORY SCIENTISTS AND ENGINEERS AT MEETINGS AND CONFERENCES. IN 1980, ARGONNE MANAGED 24 MEETINGS AT WHICH INDUSTRIAL REPRESENTATIVES MADE UP A SUBSTANTIAL PERCENTAGE OF THE 4700 VISITORS WHO ATTENDED.

THE SUBCOMMITTEES ARE INTERESTED IN EXPLORING WAYS TO INCREASE INTERACTIONS AMONG SCIENTISTS IN INDUSTRY AND THE NATIONAL LABORATORIES. ONE OF THE BIGGEST OBSTACLES TO THIS INTERACTION WE HAVE FOUND HAS BEEN THE LACK OF FAMILIARITY OF INDUSTRIAL RESEARCHERS WITH THE LABORATORIES. TO REMEDY THIS SITUATION A TASK FORCE HAS BEEN ESTABLISHED WHICH INCLUDES REPRESENTATIVES FROM THE INDUSTRIAL RESEARCH INSTITUTE (IRI) AND EIGHT OF THE MULTIPROGRAM DOE NATIONAL LABORATORIES. THIS IRI/NATIONAL LABORATORY TASK FORCE HAS BEEN IN OPERATION FOR ABOUT A YEAR NOW. ITS PURPOSE IS TO FOSTER MORE POSITIVE INTERACTION AND COOPERATION IN R&D EFFORTS BETWEEN INDUSTRY AND THE LABS. MEETINGS HAVE BEEN HELD AT ARGONNE, OAK RIDGE, AND BROOKHAVEN. SOME SPECIFIC ACTIVITIES WHICH THE TASK FORCE WILL CARRY OUT OVER THE NEXT SEVERAL MONTHS INCLUDE: DEVELOPING A MORE FORMAL MEANS FOR COMMUNICATION AND DISSEMINATION OF INFORMATION BETWEEN THE LABS AND RESEARCH INDUSTRIES; INVOLVING INDUSTRY IN THE PLANNING AND UTILIZATION OF FACILITIES

AT THE LABS; AND IDENTIFYING POSITIVE MODELS FOR INTERACTIONS WHICH MIGHT SERVE AS EXAMPLES TO BE EMULATED.

THESE ACTIVITIES ARE RELATIVELY NEW AND HAVE NOT YET BORNE FRUIT. THEY DO NOT INVOLVE THE NUMBERS OF PEOPLE OR THE RANGE OF ACTIVITIES ENCOMPASSED BY UNIVERSITY-LABORATORY RELATIONSHIPS. HOWEVER, I BELIEVE ALL THE PARTIES INVOLVED ARE ENCOURAGED BY THESE BEGINNINGS.

ANOTHER OBSTACLE TO INDUSTRY-UNIVERSITY INTERACTION IS THE LACK OF A CLEAR POLICY PROMOTING UTILIZATION BY THE PRIVATE SECTOR OF INTELLECTUAL PROPERTY DEVELOPED WITH PUBLIC FUNDS. THE CHOICES ARE TO LICENSE ON A NON-EXCLUSIVE BASIS OR TO GRANT EXCLUSIVITY. THE PROBLEM IS THAT BOTH POLICIES CAN BE APPROPRIATE DEPENDING ON THE NATURE OF THE PATENT. EVEN RECENT LEGISLATION, WHICH GRANTS PATENT RIGHTS TO SMALL BUSINESSES AND UNIVERSITIES, RECOGNIZES THE NEED (IN SOME CASES) TO GRANT EXCLUSIVITY. THE FIRST CHOICE OF THE GOVERNMENT IN COMMERCIALIZING TECHNOLOGY IS USUALLY TO GRANT NON-EXCLUSIVE LICENSES. THE IDEA IS TO SPREAD BUSINESS ACTIVITY. HOWEVER, IT IS CLEAR THAT THE PRIVATE SECTOR FEELS THE VALUE OF A PATENT IS THE PROTECTION GRANTED BY EXCLUSIVITY WHICH IS NECESSARY TO BALANCE FINANCIAL RISK IN DEVELOPING AND COMMERCIALIZING THE TECHNOLOGY. RESOLVING THESE KINDS OF ISSUES LEADS TO LONG NEGOTIATIONS, DELAYS AND UNCERTAINTY. THUS THE TIME INVOLVED IN IMPLEMENTING COOPERATIVE VENTURES WITH NATIONAL LABORATORIES IS LONGER THAN DESIRABLE FOR SOME INDUSTRIES, I BELIEVE, AND OFTEN DISCOURAGES SUCH VENTURES.

IN THE LONGER TERM FOR GOVERNMENT TO DEAL COOPERATIVELY WITH INDUSTRY IN TECHNOLOGY DEVELOPMENT, A MORE EFFECTIVE POLICY MUST BE IMPLEMENTED. THE PRIVATE SECTOR IS WILLING TO PAY FOR ACCESS TO THE FACILITIES AND CAPABILITY AT THE LABORATORIES, IF A CLEAR STRAIGHTFORWARD POLICY CAN BE IMPLEMENTED.

Program Planning and Evaluation at the National Laboratories

The Committee has also expressed interest in how the labs are managed and how research activities are planned and evaluated. With respect to planning, there has been a significant improvement over the past three or four years due to the development of the Department of Energy's Institutional Planning Process. In this process, the laboratories present to the Department tentative five-year plans containing the on-going research activities, new research initiatives which they wish to undertake, those activities which have been completed, and those the laboratories wish to discontinue. Some of the new initiatives may involve building large and complex facilities. Therefore, the planning and implementation of these programs may take several years. For example, Argonne's Institutional Plan for 1982 shows the planning for a large new electron accelerator. This electron accelerator has been recommended by the Nuclear Sciences Advisory Committee of which Dr. Bromley is a member. This accelerator will be discussed in the Department, with the larger physics community, with the Office of Management and Budget (OMB) at the appropriate time, and with Congress, in particular this Committee. We will receive back from the agency guidance as to whether the Laboratory might be supported in this venture as well as in other activities which we identified in the preliminary planning document.

The Director of Energy Research reviews the proposals submitted by each laboratory, evaluates them with those from the other multiprogram laboratories, assesses the need and the level of funding likely to be available, and then issues guidance as to which activities should be pursued and which should be dropped. The President's budget, when submitted to Congress, contains funding estimates for those programs which the Department wishes to support.

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THIS PROCESS IS NOT PERFECT, OF COURSE, BUT IT DOES PROVIDE A MECHANISM WHEREBY NATIONAL GOALS CAN BE TRANSLATED INTO SPECIFIC PROGRAM ACTIVITIES AT THE LABORATORIES. ONE DIFFICULTY IS THAT BUDGETS SUBMITTED BY THE PRESIDENT ARE NOT ALWAYS APPROVED IN THE SAME FORM BY CONGRESS. THEREFORE, THERE CAN BE SIGNIFICANT DEPARTURES FROM AN INSTITUTIONAL PLAN BY THE TIME A BUDGET IS APPROVED AND FUNDING IS PROVIDED TO THE LABORATORY.

THE ROLE OF THE CONTRACTOR (IN THE CASE OF ARGONNE, THE UNIVERSITY OF CHICAGO AND THE ARGONNE UNIVERSITIES ASSOCIATION) IS TO SEE THAT THE LABORATORY IS OPERATED IN A MANNER CONSISTENT WITH THE INSTITUTIONAL PLAN. THE UNIVERSITY AND AUA WORK CLOSELY IN THIS RESPECT WITH THE LOCAL OPERATIONS OFFICE OF THE DEPARTMENT OF ENERGY.

ALL ARGONNE STAFF ARE EMPLOYEES OF THE UNIVERSITY OF CHICAGO AND THE PERSONNEL POLICIES AND PROCEDURES OF THE UNIVERSITY ARE FOLLOWED AT THE LABORATORY. A VIRTUE OF HAVING THE LABORATORIES MANAGED BY INSTITUTIONS SUCH AS THE UNIVERSITY OF CHICAGO IS THE STANDARD OF EXCELLENCE WHICH PREVAILS AT THE UNIVERSITY IS CARRIED OVER TO THE LABORATORY. THE QUALITY OF THE TECHNICAL AND SCIENTIFIC STAFF IS THE PRIMARY RESPONSIBILITY OF THE CONTRACTING AGENT. THE GOVERNMENT, I THINK WISELY, FELT IN ESTABLISHING THIS UNIQUE ARRANGEMENT - THE "GOCO" - THAT INDEPENDENT SCIENTIFIC AND TECHNICAL JUDGMENT COULD BE GAINED BY HAVING AN INSTITUTION WHICH, THOUGH OWNED BY THE FEDERAL GOVERNMENT, DOES NOT CONSIST OF FEDERAL EMPLOYEES. THE NATIONAL LABORATORIES' ROLE IN CARRYING OUT PROGRAMS DETERMINED BY GOVERNMENT POLICIES, WHILE PRESENTING INDEPENDENT TECHNICAL AND SCIENTIFIC JUDGMENT, HAS ON MANY OCCASIONS IN THE PAST LED TO DIFFERENCES OF OPINIONS AND CONFLICT BETWEEN THE LABORATORY STAFF AND STAFF AT AGENCY HEADQUARTERS. THIS

IS A HEALTHY PHENOMENON AND IS ONE OF THE STRENGTHS OF THE LABORATORY SYSTEM. THIS CREATIVE TENSION HELPS THE GOVERNMENT OBTAIN THE BEST POSSIBLE SCIENTIFIC AND TECHNICAL ADVICE ON QUESTIONS OF NATIONAL IMPORTANCE.

Summary

THE NATIONAL LABORATORIES PLAY A KEY ROLE AT THE INTERFACE BETWEEN GOVERNMENT, INDUSTRY, AND THE UNIVERSITY COMMUNITY. THIS ROLE HAS AT LEAST TWO COMPONENTS, AND THE LABORATORIES' EFFECTIVENESS IN EACH IS CRUCIALLY DEPENDENT ON THE FACT THAT HIGH QUALITY RESEARCH IS THE MAJOR CONCERN OF THE LABS.

THE PRIMARY FUNCTION OF GOVERNMENT IN DEALING WITH NATIONAL PROBLEMS THAT HAVE A MAJOR TECHNICAL COMPONENT IS TO DETERMINE MATTERS OF POLICY AND PRIORITY. THE FUNCTION OF THE UNIVERSITY COMMUNITY IN THIS EFFORT IS TO MAINTAIN THROUGH EDUCATION THE NEEDED SUPPLY OF TALENT AND TO CONDUCT UNRESTRICTED, BASIC INQUIRY IN ALL AREAS. PRIVATE INDUSTRIES' FUNCTION DIFFERS FROM THAT OF BOTH THE LABS AND UNIVERSITIES IN THAT IT IS THE SECTOR WHICH TRANSLATES SCIENTIFIC AND TECHNICAL IDEAS INTO PRACTICAL APPLICATIONS READY FOR THE MARKETPLACE. THE NATIONAL LABORATORIES ATTEMPT TO BRIDGE THESE ROLES BY PROVIDING LARGE SCALE, FOCUSED RESEARCH AND BY RESPONDING DIRECTLY AND QUICKLY, WHEN APPROPRIATE, TO THE PRIORITIES SET BY THE GOVERNMENT. SUCH RESPONSE BY THE LABORATORIES IN THIS MANNER AND ON THIS TIME SCALE MAY NOT BE APPROPRIATE TO THE UNIVERSITY COMMUNITY AND OUGHT NOT BE REQUIRED OF THAT COMMUNITY AS A CONDITION OF FEDERAL FUNDING.

THE INVOLVEMENT AT THE NATIONAL LABORATORIES OF STUDENTS AND FACULTY IN RESEARCH PROGRAMS ALSO HELPS TO PROVIDE A STRONG SCIENTIFIC AND TECHNICAL RESOURCE BASE FOR THE NATION. AS WE LOOK FORWARD TO A PERIOD WHEN THERE MAY BE A LESS THAN ADEQUATE SUPPLY OF TECHNICAL TALENT, THESE EFFORTS ASSUME AN EVER-INCREASING IMPORTANCE.

GIVEN THEIR CURRENT SPECTRUM OF ACTIVITIES, THEIR FOCUS ON NATIONAL PROBLEMS, AND THEIR ABILITY TO DRAW ON AND SUPPORT UNIVERSITY AND INDUSTRIAL ACTIVITIES IN A SELECTIVE WAY, I WOULD SAY THAT THE NATIONAL LABORATORIES WOULD HAVE TO BE CREATED IF THEY WERE NOT ALREADY IN PLACE.

ACCESS TO ARGONNE

Argonne is not only a major center for research and development on energy-related problems but also a valuable resource for the scientific, engineering, and educational communities. Several major facilities (described in the first subsection below) are specifically designed to accommodate experiments of outside users, many others are accessible on a time-available basis, and most Argonne research programs welcome collaboration by qualified scientists and engineers from other institutions. Such interactions make for the fruitful use of facilities provided by public funds and lead to valuable cross-fertilization of ideas.

As indicated in the preamble of the AUA Founders Agreement (p.65), a prime responsibility of the Argonne Universities Association is to encourage "cooperation to stimulate scientific and technological advancement in the Midwest community and in the nation and [to promote] the maximum scientific progress and engineering development made possible by public funds and facilities." To this end the AUA seeks to facilitate mutually beneficial interactions between the Argonne staff and the university and industrial communities. The remainder of this section is an attempt to attach concrete meaning to the general invitation to outside users and collaborators.

In discussing the use of Argonne facilities, it is useful to distinguish two types of facilities. As described separately in the two subsections below, these are:

- **User Facilities**, which are major systems designed to serve the needs of independent experimental groups; the ANL operating crews provide general support and deliver the particle beams or perform other services as specified by the experimenters. This category includes not only "user-dedicated facilities" that have Program Committees to allocate all or part of their research time, but also major facilities that are provided primarily for ANL programs but which not infrequently have time available for outside users.

- **Facilities for Collaborative Research**, which are the collections of specialized apparatus in the laboratories of ANL research groups so that their use is feasible only in collaboration with ANL staff members. Most commonly the collaborative work that can be undertaken must fit into an ongoing ANL program; but on occasion the Argonne staff can undertake collaborative research on related problems brought by visitors. Such collaborative research can provide valuable experience for graduate students or advanced undergraduates in relevant disciplines.

AN INVITATION FROM THE LABORATORY DIRECTOR

I welcome this opportunity to emphasize the Laboratory's desire to develop closer ties with the university and industrial communities, as well as to stimulate more discussion with scholars and interested members of the public at large. In order to enhance the cross-fertilization of ideas and the exchange of expertise, the Laboratory would like many more visitors to collaborate in ongoing ANL programs, to take advantage of user facilities, and to become better acquainted with Argonne's intellectual endeavors.

The ANL User Facilities are set up to accommodate outside scientists and engineers coming to use certain specialized ANL equipment for their own experiments. In this connection, a particularly significant event during this year will be the beginning of operation of the Intense Pulsed Neutron Source, a user-dedicated, national facility for basic research in all areas of condensed matter, including metals, ceramics, liquids, and complex molecular and biological systems.

Almost all the varied Argonne programs welcome qualified visitors for collaboration in their ongoing research and development. As described elsewhere in this report, the Laboratory has developed different forms of appointment and financial support to fit most of the special circumstances of visitors coming for long- or short-term research. We encourage more university and industrial staff members to apply for these appointments, especially for Faculty Research Leaves at Argonne. I wish to see the number using the latter program for their sabbatic leaves grow to a steady level of 50 to 100 per year. Finally, the Laboratory offers many educationally rewarding research opportunities for students, both graduate and undergraduate.

I hope that the information provided in these pages will encourage many members of the scientific, industrial, and educational communities to take advantage of the welcome, assistance, and hospitality Argonne extends to them. Let me close with an invitation to you to come to Argonne whether or not you see a current, mutually beneficial, scientific or technical connection. We wish interested persons to visit this scientific and technical research center. Last year, over 50,000 people did.

Walter E. Massey
Laboratory Director

The subsections inviting these two types of use are intended to provide the information needed by prospective visitors. Details of Argonne or Department of Energy policy or legal restrictions wil be handled by the Laboratory personnel making the arrangements for particular visits.

Paid and unpaid research appointments are available to cover a wide variety of circumstances. The Argonne Universities Association has a program (described in a box in the subsection on User Facilities) for reimbursement of the subsistence and travel expenses incurred by U.S. and Canadian visitors using ANL facilities for their own experiments. For collaborative research, there are Visiting Scientist and Postdoctoral Appointments and a variety of other student and faculty appointments (including the relatively new Faculty Research Leaves at Argonne, described on p. 18). The host division will handle the paperwork for any such appointment as part of the arrangements for a visit.

ANL USER FACILITIES

Several major Argonne facilities—some with unique experimental capabilities—have been set up to operate in a user mode. The Laboratory actively encourages university and industrial use, and visitors are welcomed into the scientific community of the Laboratory.

Two groups of *User Facilities* are distinguished on the basis of the manner in which the DOE funds their operation. The **Funded-Operation Facilities**, which the DOE dedicates for use by the entire scientific community (not just for ANL work), assess no charges to recover operating costs provided that (1) the research is relevant to DOE interests, (2) the Program Committee of the facility has selected it as an experiment to be performed, and (3) the results are to be published in the open literature. Users pay the full expenses of their own experiments—e.g., for work done in the ANL Central Shops or for extensive computations (other than those done on-line); but if the experiment is in collaboration with ANL staff, the user pays a previously agreed fraction of the cost. Charges adequate to recover full operating costs are levied for proprietary use.

Alternatively, a User Facility may be supported by funds provided to conduct a specific ANL research program, so outside research groups (or other ANL groups) have access only on a time-available basis and may be required to pay a share of the operating costs. The charges for time on these **Cost-Recovery Facilities** depend on the nature of the facility and on other specific circumstances, but in no case does the facility recover

AUA REIMBURSEMENT OF EXPENSES OF USERS OF ANL FACILITIES

The AUA will again offer support of travel and subsistence expenses to outside users of selected ANL facilities during calendar year 1981. The broad intent of this funding is to stimulate use of these facilities and interest in them. Because of the limited funds available, the support must be limited to those investigators to whom no other sources of funds are available.

Type of work supported

Use of ANL User Facilities of types not available at the users' home institutions (i.e., the high-voltage electron microscope, accelerators, and other facilities described on pp. 10–15)

Use of other ANL facilities accessible on a time-available basis

Types of users supported

Principal investigators from outside ANL and their graduate students or assistants

- whose experiments have been approved by the program committee of the User Facility (or by the AUA if no such committee is active and if it has been established that time on the facility is available)
- who have determined that appropriate travel and subsistence funding is not available within the budget of their own research grant or contract or from departmental, university, or other institutional sources.

Expenses covered

Travel and subsistence expenses (computed from Argonne schedules for per diem and travel allowances) for visits to ANL expressly to conduct experiments at Laboratory facilities—not for preliminary discussions, exploratory visits, or other visits not for actual use of the facilities.

Maximum funding per year:
$1000 to any one individual
$1700 to any one experimental group

Calculation of AUA reimbursement for each trip:
50% of first $100 of expenses
75% of second $100
85% of third and fourth $100
100% of fifth through tenth $100

Applications; Information

To apply for AUA support, write to the Argonne Universities Association, P.O. Box 307, Argonne, IL 60439, stating what facility or facilities you plan to use and explaining why you need the support. There is *no application form.*

For questions concerning eligibility, appropriateness, and procedures, call the AUA Office: (312) 972-5455.

more than the actual cost of operation. Moreover, if a visitor's experiment is relevant to the research program under which the facility is funded, and if time is available, the Argonne staff may be able to accept an invitation to collaborate in the research—in which case, no operating costs are passed on to the visitor.

In the list that follows, the User Facilities are separated into these two categories, and the name and phone number of the person to be contacted about each facility are given. The much briefer notes at the end of each category describe facilites that are accessible in a user mode but are less available than the regular User Facilities, commonly because they have less time available for non-ANL use. The mailing address for all contact people is: Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439.

Funded-Operation Facilities
(No charge for most non-profit use)

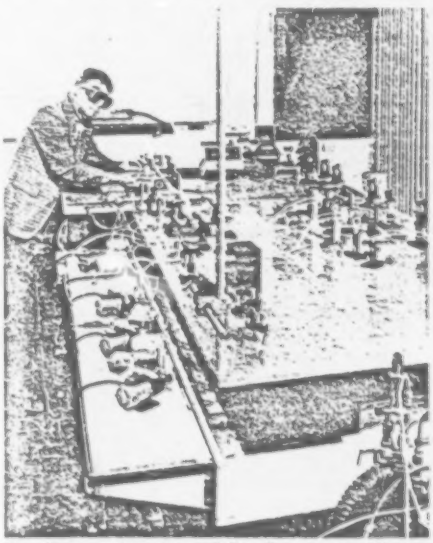
Facility for High-Resolution Atomic Spectroscopy

Contact: H.M. Crosswhite (312) 972-3637

- Large Paschen-Runge concave grating mounting
  - Plate circle: Diameter 30 ft
  - Slits: Angle of incidence 23°, 53°
  - Reciprocal dispersion (typical) 0.45Å/mm
  - Resolving power $>5 \times 10^5$
  - Conventionally ruled and holographic gratings
  - Provision for photoelectric scanning of spectrum (for precise intensities)
- Czerny-Turner 2-mirror vacuum spectrograph
  - Focal length 5 m
  - Plane grating, width up to 10 in.
  - Resolution $>10^6$
  - Stigmatic
- Jarrell-Ash Ebert spectrograph
  - Focal length 3.4 m
  - Plane grating, width 6 in.
  - Stigmatic
- McPherson vacuum spectrograph
  - Plate circle: Diameter 3 m

General Accessories

Light sources (line, continuum)
Tunable dye-laser systems
Magnets for Zeeman effect
  Coventional, 2.5 Tesla
  Superconducting, 5.0 Tesla uniform to 1% over full 24-in. length of room-temperature bores
  Solenoid: 2-in. bore diameter
  Dipole: 4-in. bore diameter
Heat-pipe and high-temperature (up to 2650°C) furnaces for studies of absorption by metal vapors
Automatic plate-measuring comparator, interfaced with computer for wavelength determinations

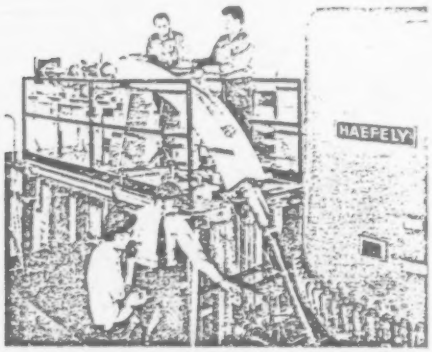


Dye laser equipment used for four-wave mixing to generate tunable coherent vacuum ultraviolet radiation.

High Voltage Electron Microscope—Tandem Facility

Contact: A. Taylor (312) 972-5005

This facility for materials research provides unique combinations of the techniques of advanced high-voltage electron microscopy, ion implantation, ion bombardment, and ion-beam analysis. The ion-beam interface permits direct microscopic observation of the effects of electron and ion bombardment o. naterials. A Steering Committee of ANL, universit , and industrial representatives evaluates research proposals and allots use time; non-ANL use is ~50%. The principal components of the facility are:



The new ion-beam interface of the HVEM-Tandem Facility. The accelerated ion beam comes in at top left, passes through the electrostatic deflector, and goes to the microscope via the tube at lower right. The electron source and accelerating column are in the Haefely tank (right) directly above the microscope.

- Kratos/AEI-EM7 high-voltage electron microscope

Voltage, continuously variable	100—1200 kV
Lattice resolution	3.5 Å
Observation temperature:	
under high vacuum	10—1300 K
in gas ≤ 250 Torr	ambient—1300 K
Specimen thickness	≲5 μm

- Ion-beam interface
- 300-kV heavy-ion accelerator
- National Electrostatics Type 2UDHS tandem accelerator (spring 1981)

Terminal voltage (max.)	180—2000 ± 0.250 kV
Ion beams:	all stable isotopes in the periodic table
Typical beam current	10 μA protons to 0.1 μA $^{208}Pb^{+}$

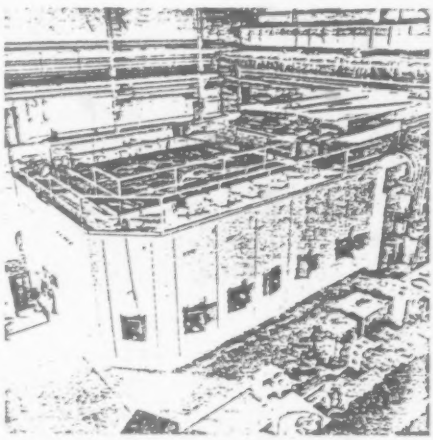
Intense Pulsed Neutron Source I (IPNS-I)

Contact: T.G. Worlton (312) 972-6800

IPNS-I is a national user facility dedicated to basic research on condensed matter in the areas of neutron scattering and radiation effects. Neutron scattering is used to study the static and dynamic structures of crystals, glasses, and liquids; voids and defects in solids; structural tranformations associated with magnetic, crystallographic, and electronic phase changes; spin waves and magnetic structures in solids; and structural arrangements in surface-absorbed films, in polymers, and in biological materials. Radiation-effects studies include fast-neutron damage production and annealing at low (4 K) and high temperatures, mechanical properties, microstructural changes, defects in semiconductors, and radiation effects in fusion-magnet materials.

IPNS-I is scheduled to begin operation in 1981 with an initial complement of seven neutron-scattering instruments and capabilities for studying radiation effects from 4 to 800 K. The initial performance specifications of the facility are:

Peak thermal flux	3×10^{16} n cm^{-2} s^{-1}
Peak epithermal flux (1 eV)	10^{15} n cm^{-2} s^{-1} eV^{-1}
Time-ave. fast flux (>0.1 MeV)	2×10^{12} n cm^{-2} s^{-1}
Repetition frequency	30 Hz
Time-of-flight resolution of neutron wavelengths	$\Delta\lambda/\lambda \geq 0.3\%$



IPNS-I in October 1980, before completion of the neutron generation system and installation of neutron scattering instruments. Six of the neutron beam tubes can be seen coming out of the shield monolith, which contains 1 00 tons of steel shielding.

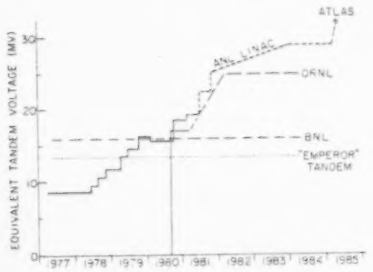
A Program Committee headed by Dr. J. M. Rowe of the National Bureau of Standards will review experiments proposed for IPNS-I and select those having the greatest scientific merit. Information about procedures for submitting proposals for experiments is included in the January 1981 issue of the quarterly IPNS Newsletter, which will be sent on request.

Argonne Superconducting Heavy-Ion Linac

Contact: D.G. Kovar (312) 972-4031

This linear accelerator is an energy booster for heavy-ion beams produced by the 9-MV Tandem Accelerator. Although heavy-ion beams are now available for experimental use, it is still advisable to plan a collaborative effort with an Argonne group that keeps abreast of the rapidly changing status of the new facility. The plans for the eventual user facility are described in the ATLAS proposal and current information is disseminated through a Linac Newsletter, both available through D.G. Kovar.

Representative ions	Maximum beam energy	
	from Tandem	from Linac
^{16}O	70 MeV	160 MeV
^{32}S	77	230
^{37}Cl	85	280
^{58}Ni	85	330



Performance of the compound ANL system, described in terms of an equivalent tandem with two strippers.

Principal Parameters

Ions accelerated:
Certain species in the range $4 \le A \le 64$

Ion energy, depending on species 5—15 MeV/A

Beam current (time average) depending on species (pnA = particle nanoampere) ≲10 pnA

Longitudinal emittance of beam:
$\Delta E \cdot \Delta t \approx 2 \times 10^{-11}$ MeV.s
$\Delta t^{max} \approx 50$ ps

Height of beam line 69 in.

Auxiliary Equipment

Computer-controlled 65-in. scattering chamber. Four detector arrays can be moved in or out of the reaction plane

Neutron/charged-particle time-of-flight chamber, with 1-m fight path for charged particles

General-purpose gamma-ray facility, with a sum/multiplicity spectrometer

On-line PDP 11/45 computer

1-ton crane serving target area

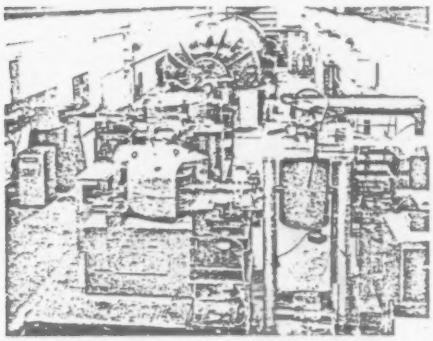
Enge split-pole spectrograph (in FY 1981), similar to the one at the 9-MV Tandem

Tandem Accelerator Facility

Contact: J.L. Yntema (312) 972-4024

The Physics Division 9-MV Tandem Accelerator has a Pelletron charging system, a metal-and-ceramic accelerator tube, an ultra-high vacuum system, and a carbon foil stripper (in the high-voltage terminal). Its negative-ion sources are an inverted sputter source, a direct-extraction duoplasmatron, and a lithium charge-exchange source. It accelerates many species of gas and metal ions into a 50 × 50-ft shielded experimental area. Some of the principal parameters and experimental facilities are:

Ion current	a few nA to 1 μA
Electrode voltage (continuously variable)	2—9 MV
Energy stability, ΔE/E	~1/1000
Height of beam lines	69 in.



View of the 9-MV Tandem with the analyzing magnet of the injection system and (to the right of the magnet) the ion sources.

Experimental Facilities

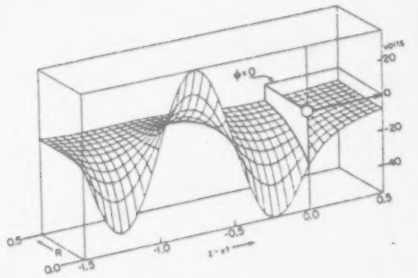
Enge split-pole spectrograph with a focal-plane detector measuring E, ΔE, and particle position
ΔE/E = 1/2000, Mass-energy product = 90, Solid angle = 3 msr
70-in. computer-controlled scattering chamber with four arms to carry detector arrays
Transport systems to quickly move short-lived samples from the target position to a shielded area for counting
On-line PDP 11/45 computer with appropriate hardware and software
5-ton crane to service the experimental area

4-MV Dynamitron Facility

Contact: A.J. Elwyn (312) 972-4055

A wide variety of experimental systems for ongoing research programs in charged-particle physics and in materials science occupy most of the beam lines. Although the Dynamitron is not a funded facility, user time is available as if it were — within the limits imposed by an intensive ANL research program. A 2-ton crane services the target area, and an on-line PDP 11/45 computer with a variety of hardware and software is available. Some of the principal paramters are:

Beams	atomic or molecular ions of many species
Ion energies (present)	300 keV—4.0 MeV
Beam energy spread	<1 keV
Ion currents (steady)	a few nA to tens of μA (higher for light ions)
If beams is pulsed:	
Pluse width	variable from nanosecond to millisecond range
Duty cycle	~1% to ~25%
Height of beam lines	65 in.



The electronic "wake" potential which trails a fast-moving ion as it traverses a solid medium. The ion was accelerated by the Physics Division's 4-MV Dynamitron.

Biological-Materials Growth Facility

Contact: H. L. Crespi (312) 972-3686

This is a facility in which plant micro-organisms produce deuterated and other isotopically labeled compounds for use in magnetic-resonance, infra-red, and Raman spectroscopy and in neutron-scattering analysis. Use of the facility is restricted to the production of materials not available commercially. Fully deuterated green and blue-green algae, photosynthetic bacteria, and *Halobacterium halobium* are cultured on a multi-liter scale. Organisms substituted with ^{17}O and ^{15}N are cultured on a more modest scale.

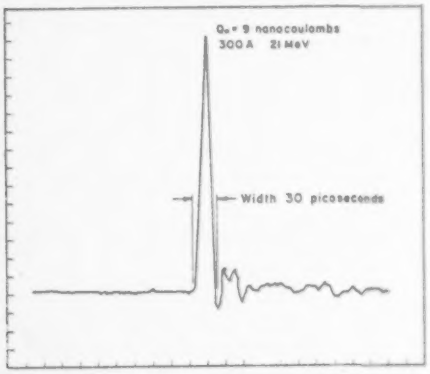
Cost-Recovery Facilities

Chemistry Division Low Energy Accelerator Facilities

Contact: Jack Aron (312) 972-4895

■ **Pulsed Electron Linac**, a pulsed L-band linear accelerator with a no-load energy of 22 MeV. It is used in the Chemistry Division's Radiation Chemistry

Program and in the Physics Division's Photoneutron Program (high-resolution neutron spectra near threshold). A beam transport/analyzing system is available. The current capabilities of the Linac are:

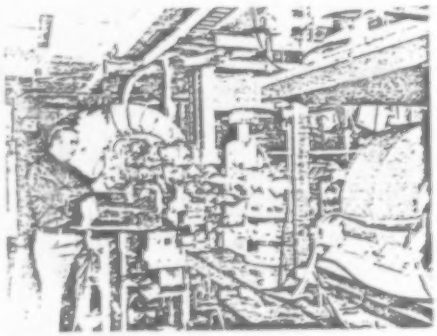


Single electron pulse achieved with the Subharmonic Prebuncher of the Argonne Linac.

- Peak current 2.5 A for pulse width 0.6—11 μs, repetition rate 1—120 pps, loaded energy 14 MeV
- Maximum current 22 A for pulse width 4—20 ns, repetition rate 1—800 pps
- Peak current 300 A for pulse width < 30 ps, repetition rate 1—800 pps

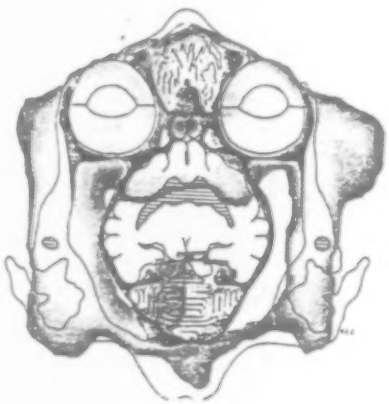
■ **3-MeV Van de Graaff,** energy range 0.5—3.0 MeV. It is used in studies of magnetic effects in reactions of radicals generated by pulse radiolysis and in ultrafast EPR spectroscopy to study short-lived radical species and the products of those transient intermediates examined by NMR spectroscopy. A multi-port beam-transport system is available. This accelerator is operated in either a DC or a pulsed mode.

- DC: electrons up to 1 mA; protons up to 0.5 mA
- Pulsed (electrons only): pulse width 1 ns—10 μs, peak current < 3 A, repetition rate 10—100 pps up to 100 ns, 10—10^4 pps up to 10 μs



Van de Graaff accelerator and the Electron Paramagnetic Resonance magnet used in the study of transient radicals produced by electron radiolysis.

■ **60-in. Cyclotron,** a fixed-frequency machine capable of producing beams up to 100 μA or more of



Tomographic (3-dimensional) reconstruction of the distribution of ^{77}Br-bromospiroperidol (BrSp) in the median plane (horizontal) of the head of a living cat. The BrSp distribution (color) is shown superimposed on an anatomical drawing of the same plane. The short-lived gamma-emitting ^{77}Br in this drug was produced in the ANL cyclotron. Since the BrSp concentrates in certain areas of the brain and other nerve tissue, use of a gamma-ray camera permits measurements of neurological parameters in the living animal.

protons	up to 10.6 MeV	helium-3	up to 33.9 MeV
deuterons	up to 21.1 MeV	helium-4	up to 42.8 MeV

Neutron fluxes exceeding 10^{11} $cm^{-2}s^{-1}$ (median energy 8 MeV) can also be produced. A beam transport/analyzing system with beam-chopping capability serves one experimental area but the other two areas receive only the unanalyzed beam. This cyclotron is especially suitable for isotope production (primarily for nuclear-medicine and waste-management studies) and radiation-damage studies.

Users Support Center

Contact: P.F. Schultz (312) 972-6253

The Center serves university groups in high-energy physics by making available the unique facilities and many fields of expertise developed at the Zero Gradient Synchrotron. These include:

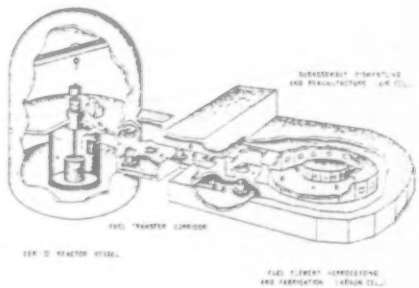
- Plastics Shop with facilities for bonding, shaping, molding, and fabricating items using all types of plastics and materials. Also coil winding and fabricating facilities for magnet coils.
- Detector fabrication facility for large-area wire spark chambers and foils.
- Electrical engineering, especially for power supplies (high-voltage, high-current, fast-rise-time) for magnets and other high-performance applications such as Marx generators, Blumlein lines, streamer chambers.
- Design of magnets (superconducting and conventional) and associated cryogenic equipment, field calculations, and advice on construction.
- Polarized targets — especially vacuum, cryogenic, and microwave techniques.
- Large high-bay halls for use as assembly or staging areas. Each has an overhead crane of 35-ton capacity.
- Test beam of pions and protons (up to several hundred MeV kinetic energy) from the Rapid Cycling Synchrotron by mid-1981.
- ANL machine shops with extensive experience and large-capacity machine tools for constructing and fabricating high-energy physics equipment.
- Discussions and planning in other fields (e.g., computer control, high-vacuum technology, mechanical engineering, microwave technology) pertaining to applications in high-energy physics experiments.
- Equipment and instruments for testing, calibrating, and installation.

Initial discussions with Center personnel will be paid for by the Center, but the costs of any detailed engineering, shop work, and materials will be borne by the User. However, it is possible that part of the expenses for some projects can be covered by other sources.

Hot-Cell Facilities (312) 972-4863

Contact: Associate Laboratory Director,
Reactor Research and Development

Both ANL-West and the Illinois site have several large, heavily shielded hot cells with auxiliary testing, examination, and handling equipment. Current information about costs, design parameters, and availability can be obtained at the office indicated above.



Schematic drawing showing the fuel flow through the Hot Fuel Examination Facility—South (HFEF/S) when it operated as the fuel recycle facility for EBR-II. (See also under Argonne-West, p. 28.)

Coal Liquefaction Heat Transfer Coefficient Measurement Unit

Contact: T.P. Mulcahey (312) 972-6039

This unit is used to determine the coefficients of heat transfer between coal-derived fluids and metal surfaces. The data obtained are useful in the definitive design of feed and effluent heat exchangers for use in desulfurization and liquefaction of coal to produce fuel for commercial processes. This facility is not currently being operated and a user would be required to fund the operating costs.

COLLABORATIVE RESEARCH AT ANL

Most Argonne research programs welcome qualified collaborators with appropriate interests; and outside experiments needing special Argonne facilities can often be undertaken on a collaborative basis. The existence of common interests, the feasibility of collaborative research, and the availability of a paid or unpaid research appointment at ANL are best explored with the appropriate ANL staff members and their division offices.

The subsection on **Argonne R&D Divisions and Programs** describes the research divisions and their programs as an aid in finding divisions with interests relevant to your own. If you are a potential collaborator who is not acquainted at Argonne, your best approach probably is to send a brief description of your research interests to the office of the division that seems most likely to conduct such work, with a request that your letter should be circulated to other divisions if this seems appropriate. If you are in doubt about which division to contact, call or write the ANL Office of Public Affairs: (312) 972-5580.

A variety of paid and unpaid, long- and short-term, summer and academic-year appointments for collaborative research by faculty members, post-doctorals, graduate students, and undergraduates are briefly described in the following subsection. (A modest AUA program to reimburse certain expenses of approved users, who come to perform their own experiments with certain ANL facilities, is described above on p. 9.)

Paid and Unpaid Appointments for Collaborative Research

The Division of Educational Programs provides an administrative focus for educational and training interactions between Laboratory divisions and educational programs, both in universities and colleges and in energy industries. In its efforts, the DEP is aware of the need to increase the participation of women and minorities in scientific and energy-related occupations. The paid and unpaid appointments for collaborative research by faculty and students (and incidentally the faculty institutes and workshops) are described below. In addition, the Division conducts a variety of conferences as illustrated by the accompanying list.

Moreover, Argonne National laboratory uses some research funds to offer education-related temporary employment for a limited number of faculty members and postdoctoral appointees. These appointments are administered by the ANL Personnel Division in consultation with the division in which the temporary employee would work.

The Department of Energy offers graduate and undergraduate students some additional work/study opportunities administered through its Chicago Operations and Regional Office at Argonne. The National Consortium for Graduate Degrees for Minorities in Engineering (the GEM program) also offers attractive appointments for advanced engineering students. Note that the AUA Reimbursement of Expenses of Users of ANL Facilities, though listed here for completeness, is

ANL/UNIVERSITY CONFERENCES

Biological Aspects of Ecosystem Restoration
13th AUA-ANL Biology Symposium, April 21–22, 1980.

Materials Science Problems in Synthetic Fuels Technology
Materials Science Conference, June 5–6, 1980.

Conference on Opportunities for Participation in Energy Research and Development
ANL Division of Educational Programs
and
Atlanta University Resource Center for Science and Engineering,
June 12–13, 1980

Risks of Low Level Radiation
18th AUA-ANL Nuclear Engineering Conference, September 15–17, 1980.

Synthetic Fuels: Promise and Problems
Central States Universities, Inc., November 6–7, 1980

The Division of Educational Programs conducts three or four such conferences per year. As this report goes to press, plans for the 1981 conferences are not yet final; for information about them, call the ANL Division of Educational Programs: (312) 972-3374.

for users of special ANL facilities, not for collaborative research.

These available programs are listed separately for Faculty Members, Postdoctoral Appointees, International Trainees, Graduate Students, Undergraduates, and High School Students. Note that many of the appointments are restricted to U.S. Citizens and that some have deadlines for applications.

Since the programs are funded from several different sources and are subject to correspondingly different regulations, they are administered through different offices as indicated by the notations DEP, PER, OWMP, AUA, DOE, and GEM associated with the program titles. The addresses of the offices referred to by these acronyms are:

DEP
Division of Educational Programs
Argonne National Laboratroy
9700 South Cass Avenue
Argonne, Illinois 60439
(312) 972-3373

OWMP
Office of Waste Management Programs
Argonne National Laboratroy
9700 South Cass Avenue
Argonne, Illinois 60439
(312) 972-6677

DOE
U.S. Department of Energy
Organization and Personnel Division
9800 South Cass Avenue
Argonne, Illinois 60439
(312) 972-2314

PER
Personnel Division
Argonne National Laboratroy
9700 South Cass Avenue
Argonne, Illinois 60439
(312) 972-2971

AUA
Argonne Universities Association
P.O. Box 307
Argonne, Illinois 60439
(312) 972-5455

GEM
Executive Director
National Consortium for Graduate
Degrees for Minorities in
Engineering, Inc.
University of Notre Dame
Box 537
Notre Dame, Indiana 46556
(219) 283-1304

FACULTY APPOINTMENTS

Faculty Research Leaves at Argonne DEP
(Scientist-in-Residence)
Supplements a sabbatic leave (typically 9–12 months, or up to 2 years) for research at ANL.
Regular salary and fringe benefits; moving allowance
For details on program policies, eligibility, financial support, and the application and selection process, see p. 18.

Faculty Research Participation DEP
(Resident Research Associate)
Short-term (typically 10–12 weeks) collaborative research in the summer or (less commonly) the academic year.
Weekly stipend (restricted to U.S. citizens on the faculties of U.S. academic institutions) is calculated as 1/40 of the current academic-year salary less any support received from other sources, but not exceeding $500/week; travel allowance.
Applications are due by mid-January.

Fossil Energy Research Residencies DEP
(Resident Research Associate)
Summer research on fossil fuels in collaboration with ANL scientists.
Administered as part of the Faculty Research Participation Program (above) but funded by the DOE Fossil Fuels Program.

Visiting Scientists PER
Temporary employment at ANL, typically for a summer or for 1 year.
Salary comparable to that at the home institution.

Resident Associates PER
Unpaid guest appointments to allow collaboration with ANL staff and/or use of ANL facilities on an intermittent schedule.

AUA Reimbursement of Expenses of Users of ANL Facilities AUA
For faculty members and their assistants coming to use ANL facilities for their own experiments.
Limited to reimbursement of travel and subsistence expenses for users to whom no other sources of funds are available.
For details on the type of work supported, eligibility requirements, and expenses covered, see p. 9.

FACULTY RESEARCH LEAVES AT ARGONNE (FRLA)

FRLA Policies

Faculty Research Leaves at Argonne are designed to accommodate the typical needs of tenured faculty members wishing to use their sabbatic leave for 1–2 years of research at Argonne. This program promotes interaction and partnership between visiting faculty members and Argonne scientists and engineers and encourages continuing research collaboration in areas of mutual interest.

- Faculty researchers supported by this program will hold Scientist-in-Residence appointments and will participate in ongoing programs of the Laboratory.
- Appointments are normally for a calendar year but may continue up to a maximum of two academic years plus the three contiguous summers if this is agreed upon by the faculty member, the home institution, and the Argonne host division.
- The Division of Educational programs (DEP) is responsible for administering the FRLA program in cooperation with the ANL research-and-development division in which the visitor is to work and with the Personnel Division.

Eligibility

To be eligible for a FRLA appointment, a faculty member must have:

- a sabbatic leave award (or other appropriate financial support) from his or her university,
- the approval of the appropriate university administrator so he or she can accept the Argonne appointment if offered, and
- a record of scientific or engineering accomplishments that indicate a mutually beneficial research leave at Argonne.

Financial Support

- During the FRLA assignment, the faculty member remains on the university payroll and retains the fringe benefits.
- The university's reimbursement from Argonne research-and-development funds is typically 50% of salary and fringe benefits for a nine-month appointment and 100% of summer salary and fringe benefits. Any higher level of reimbursement by Argonne requires review and approval on an individual basis.
- In addition, Argonne directly reimburses the faculty member for travel, moving, and housing expenses in accordance with ANL policies. These covered expenses include those for:
  - travel before and after the appointment, including interview travel as appropriate,
  - authorized domestic travel appropriate to the Argonne assignment, such as that for participation in off-site Laboratory activities and attendance at conferences, workshops, and meetings,
  - occasional travel back to the faculty member's university for required consultation with graduate students,
  - shipment of household goods and personal effects before and after the appointment, as authorized by Argonne,
  - temporary lodging and per diem allowance, as authorized by Argonne, and
  - certain unusual housing costs.
- If an FRLA appointment extends beyond the sabbatic year, Argonne reimburses the faculty member's university for that fraction (up to and including 100%) of the salary and fringe benefits not provided by the university.

Application and Selection Process

- A faculty member interested in FRLA participation should write a letter of interest addressed to:

  Office of the Director
  Argonne National Laboratory
  9700 South Cass Avenue
  Argonne, Illinois 60439

- This letter should be accompanied by a curriculum vitae, a publication list, and a brief statement of current research interests.
- This material should be given to the appropriate university official, who should be asked to add an official university endorsement (including assurance that the faculty member is eligible to receive a sabbatic award or equivalent financial support) and to transmit this dossier to the Office of the Director, ANL.
- Using the information provided by the faculty member and his or her university, the director of the Division of Educational Programs works with the appropriate Argonne divisions to assess mutual interests and to suggest direct contacts between Argonne scientists and the faculty member to clarify research opportunities.
- After the foregoing discussions, the Director of DEP contacts the FRLA applicant. If circumstances appear to favor an appointment, the director invites the faculty member to confirm his or her interest in the program by submitting a written request for an appointment.

- Criteria employed in reviewing requests for appointments include:
  - university endorsement of the request and the availability of a sabbatic leave award.
  - the professional qualifications of the faculty member in relation to the ongoing Argonne program, and
  - the availability of Argonne resources to support the participation.
- The director of DEP informs the faculty member and the university, in writing, of the disposition of the request for an appointment.
- Counseling and assistance on housing in the Argonne area will be provided.

For further information on this program, contact:

Division of Educational Programs
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
(312) 972-3373

Current FRLA Participants

The first sixteen Faculty Research Leave participants, their home departments and institutions, and their ANL host divisions and research groups are:

Mark A. Bambenek, Department of Chemistry, St. Mary's College, Notre Dame, Indiana; Energy and Environmental Systems Division, Land Reclamation

Huei-Huang Chiu, Department of Energy Engineering, University of Illinois at Chicago Circle; Energy and Environmental Systems Division, Systems Engineering and Technology

Paul S. Denise, Division of Social and Community Services, Southern Illinois University, Carbondale; Division of Environmental Impact Studies, Socioeconomics

Harry L. Downing, Department of Physics, Drake University, Des Moines, Iowa; Materials Science Division, Basic Ceramics

Zbigniew W. Grabowski, Department of Physics, Purdue University, West Lafayette, Indiana; Physics Division, Heavy Ion Physics

David S. Hacker, Department of Energy Engineering, University of Illinois at Chicago Circle; Chemical Engineering Division, Fluid Catalysis

James F. Harrison, Department of Chemistry, Michigan State University, East Lansing; Chemistry Division, Theoretical Chemistry

Alvin L. Jensen, School of Natural Resources, University of Michigan, Ann Arbor; Radiological and Environmental Research Division, Ecological Sciences

Walter R. Johnson, Department of Physics, University of Notre Dame, Notre Dame, Indiana; Radiological and Environmental Research Division, Fundamental Molecular Physics and Chemistry

Philip D. Kearney, College of Natural Sciences, Colordao State University, Fort Collins; Division of Environmental Impact Studies, Radiological Science

T. Thomas Lin, Department of Chemistry, Washington University, St. Louis, Missouri; Chemistry Division, Radiation Chemistry

Ewing L. Lusk, Computer Science Division, Northern Illinois University, De Kalb; Applied Mathematics Division, Applied Mathematical Science

Dennis Nyberg, Department of Biological Science, University of Illinois at Chicago Circle; Biological and Medical Research Division, Circadian Cybernetics

John E. Potts, Department of Physics, University of Michigan—Dearborn; Solid State Science Division, Solar Materials

Malcolm F. Steuer, Department of Physics and Astronomy, University of Georgia, Athens; Physics Division, Molecular Ion Beams

Lettie McSpadden Wenner, Department of Political Science, University of Illinois at Chicago Circle; Energy and Environmental Systems Division, Integrated Assessments and Policy Evaluation

Faculty Institutes DEP

1-week instructional sessions offered during breaks in the academic calendar, especially during the summer.

Aimed to introduce DOE programs and to aid curriculum development and research on energy and the environment.

Living allowance (limited to U.S. Citizens): $120; partial travel reimbursement.

Planned institutes for Summer 1981:

June 1-5, 1981	Impact of Energy Use and Production on Water Quality
June 8-19, 1981	Transmission Electron Microscopy in Biological and Materials Research
June 15-26, 1981	Chromatographic Analysis of Energy-Related Pollutants
June 22-26, 1981	Solar Energy Conversion

Faculty Workshops DEP
Usually Friday-Saturday during the academic year.
Designed to acquaint participants with apparatus and techniques for investigations in energy technology and environmental quality, especially as aids to course development.
No financial assistance.
In March and April of 1981, twelve workshops (each on a separate topic) were held on five weekends.

POSTDOCTORAL APPOINTMENTS PER

Annual appointments, renewable up to 3 years.
Salary ranges:

0—1 yr since Ph.D.	$1300-1700/month
1—2	$1400-1810
2—3	$1500-1925

INTERNATIONAL TRAINING FOR ENERGY MANPOWER DEVELOPMENT DEP

Nuclear-power training courses, typically lasting for 1—2 months, for persons from developing countries.

GRADUATE STUDENT APPOINTMENTS

Laboratory-Graduate Thesis Appointments DEP
Ph.D. or master's degree research under the supervision of the university research professor and an ANL staff member.
Student must have completed all other requirements for the degree.
Stipend (restricted to U.S. citizens): $550/month; tuition up to $3000/year; travel allowance.
Applications due by March 1 if appointment starts in summer or fall
by October 1 if appointment starts in winter or spring

Thesis-parts Appointments DEP
For graduate students coming to use ANL facilities or to confer with ANL staff for portions of their dissertation research.
Available for periods varying from a few days up to 6 months.
Expense reimbursement (restricted to U.S. citizens): travel allowance; up to $20 per diem.

Student Research Participation (Summer) DEP
11-week program for superior science, mathematics, or engineering students, preferably with no more than 1 year of graduate study completed.
Stipend (restricted to U.S. citizens): $175/week; travel allowance.
Research is supplemented by a seminar series on Energy Research, Biology Research, or (at Argonne-West) Nuclear Engineering.
Applications due by February 1.

Student Research Participation (Academic Year) DEP
16-week program for superior science, mathematics, or engineering students, preferably with no more than 1 year of graduate study completed.
Honorarium (restricted to U.S. citizens): $900 for the term; travel allowance; free lodging in the ANL student apartments.
Credit may be granted at the discretion of the college or university.

Resident Student Associates DEP
Education-related temporary (up to 6 months) employment for superior graduate students.
Salary range: $1000—1800/month, determined by the number of terms of study completed.

DOE Cooperative Education Programs DOE
Restricted to U.S citizens who are full-time graduate students at qualified institutions with a co-op program.
Program in Accounting, Business, and Chemistry, and in Chemical, Electrical, Mechanical, and Nuclear Engineering.
Salary: Depends on the person's education and related work experience.

DOE Thesis Research—Nuclear Waste Management OWMP
Research on a Master's thesis in a discipline related to nuclear waste management, to be conducted at the student's university under the guidance of his research professor. The duration of the award is from February 1, 1981 to May 31, 1982; brief quarterly technical reports and a final detailed report to Argonne National Laboratory are required. Funding for future years has not yet been obtained.
For U.S. citizens who are full-time graduate students at accredited U.S. colleges or universities.
Financial assistance: The DOE provides up to a total of $10,000 for each accepted proposal, payable in two installments to the student's college or university.

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National Consortium for Graduate Degrees for Minorities in Engineering, Inc. GEM

Career-related summer employment (about 12 weeks) and academic-year scholarships to promote the education of minority members to the master's level in engineering.

For American citizens who are American Indians, Black, Chicanos, or Puerto Ricans. Applicants must be at least in their junior year, but may be seniors or recent graduates.

Summer salary commensurate with that paid like employees.

Academic year stipend: $4000 per academic year, plus tuition.

Interest in work at ANL may be indicated in the application.

Deadline for completed application: December 1 of each year.

Energy Information Administration Research Residencies DEP

One year of research experience in the DOE Energy Information Administration in Washinton, D.C.

Stipend: $1000/month; travel allowance; tuition reimbursement up to a maximum of $1500.

Policy and Evaulation Research Residencies DEP

One year and/or summer of research experience in the DOE Policy and Evaluation Administration in Washington, D.C.

Stipend: $1000/month; travel allowance; tuition reimbursement up to a maximum of $1500.

Fusion Engineering Research Residencies DEP

Six months of fusion research at a major corporation, under the sponsorship of the DOE fusion program.

Stipend: $1000/month; travel allowance; tuition reimbursement.

UNDERGRADUATE STUDENT APPOINTMENTS

Summer Research Participantships DEP

An 11-week program of research participation supplemented by a related series of seminars.

Stipend (restricted to U.S. citizens): $150/week; travel allowance.

Applications due by February 1.

Academic-Year Research Participantships DEP

A 16-week program of research participation for superior students.

Honorarium (restricted to U.S. citizens): $700 for the term; travel allowance; housing for single students in the ANL student apartments.

Academic credit may be offered at the discretion of the student's college or university.

Applications due by April 1 for the fall term (starting in September)
by October 1 for the spring term (starting in January)

Student Aides DEP

Education-related temporary employment of superior undergraduates as assistants to ANL scientists.

Salary range: $230—258/week, determined by the number of terms of study completed.

ANL Co-op Program DEP

Temporary employment for undergraduates in colleges or universities offering programs of alternating work and study.

Salary: competitive, based on the number of terms of study and co-op work completed.

DOE Cooperative Education Program DOE

Temporary employment in DOE offices for students in Accounting, Business, or Chemistry and in Chemical, Electrical, Mechanical, or Nuclear Engineering.

Restricted to U.S. citizens who are full-time students who have completed two years at a qualified college or university.

Salary: Depends on the person's education and related work experience.

Physically Handicapped in Science DEP

A 1-week research-exposure program for physically handicapped undergraduates.

Funded by the National Science Foundation.

HIGH SCHOOL STUDENT APPOINTMENTS

Pre-Coop Program DEP

Ten-week summer program of research participation for outstanding high school graduates planning college majors in science and engineering.

Stipend: $120/week

Minority High School Summer Research Apprenticeship Program DEP

Summer academic enrichment and laboratory experience for high school students between their sophomore and junior years.

Mr. FUQUA. Thank you very much, Dr. Massey, and we do appreciate very much your very fine testimony. For that matter, we appeciate the testimony from all of the witnesses whom we have had this morning.

Should each of the DOE multipurpose labs be assigned a principal mission, say, fossil or fusion or conservation, or should they continue to maintain the diversity of activities and expertise, similar to the case now?

I don't aim that at anybody, but maybe—Dr. Keyworth?

Dr. KEYWORTH. Mr. Chairman, I think we could learn something by examining the Department of Defense laboratories that are far narrower in scope. I believe that one of the strengths of the DOE national laboratories is their multidisciplinary nature. I think it is synergistic; I think it is a basis for their excellence; and I would contend that it is why, in terms of quality, the DOE national laboratories are generally recognized as being considerably superior to the Department of Defense laboratories.

So, in short, I would not recommend that the scope of these laboratories be narrowed.

Mr. FUQUA. That was the other part of a question. Can their industry relations and university relations compare with those of the other Federal agencies, one being DOD and the other being NASA?

Dr. KEYWORTH. In my opinion, the Department of Energy has certainly not been as effective as NASA in technology transfer and in establishing a working relationship with industry.

I might point out that since the Department of Energy's mission has itself lacked definition relative to NASA's, I think that in part accounts for this problem.

Mr. FUQUA. Of course, that's one of the things that we're concerned about, as you mentioned, technology transfer. How do we get the technology back to industry so that the return on the taxpayers' funds are maximized?

Do you have any comment, Dr. Bromley?

Dr. BROMLEY. Mr. Chairman, it seems to me that one of the channels that certainly would be worth examining, and that is beginning to function, is that of bringing industrial personnel into the national laboratories to pursue some of the activities generated within their own industries, because by making that contact on an individual basis, by becoming familiar with what the laboratories can offer, I think that the transfer will take place in a much more natural way.

In fact, I have long suspected that it is very difficult to force technology transfer, but it may be possible to make it happen in a synergistic way, as Dr. Keyworth suggests, by exposing people—Dr. Massey made the same point—by making it much more obvious to personnel from industry what they can get from the national laboratories in terms of help, in terms of processes, products, expertise and what-have-you.

Mr. FUQUA. Another question that comes to mind, and I've had people discuss this with me, is a regional mission, where the labs try to serve regional industries, universities, and the Government in their own part of the country. How would that affect a lab such as Argonne, Dr. Massey?

Dr. MASSEY. I think such a role would be consistent with the mission of a lab like Argonne, which is a diverse laboratory. It's one of the things, in fact, which we proposed in our institutional plan last year, that Argonne move to try to create a regional role. Being the only major multiprogram lab in the Midwest, I think it could fit our mission even better. We've already begun to talk with industrial firms around the Chicago area about how we might cooperate with universities and industry in defining such a role.

May I respond briefly to your first question?

Mr. FUQUA. Certainly.

Dr. MASSEY. To agree with Dr. Keyworth, I think it would not be appropriate to have each DOE lab assigned a role focussing around a particular technology. Technologies have limited lifetimes and there are appropriate times in which certain kinds of research should be done.

Also, it's difficult to discount the kind of synergistic effect which comes out of a multidisciplinary research institution.

I have placed on the table at the side of the room some products which have come out of Argonne's research efforts that I'd invite the members of the committee and staff to look at. Some of these, in fact, are part of our basic research program, but will have applications for technology in the future.

Mr. FUQUA. Dr. Bueche, would you like to comment on any of the questions?

Dr. BUECHE. I think, Mr. Chairman, the national labs could be focused, perhaps not on specific technologies, but as Abraham Lincoln, I guess, said, let's let the Government do the things for the people that the people can't do for themselves. When I find Oak Ridge planting trees to see if they can't grow them a little closer together and faster, which the paper companies could do, or testing solar cells that there are many companies already set up to test, and so on, I just wonder if we haven't lost our sense of focus altogether.

Now I am with Dr. Keyworth and Dr. Massey. I don't think I would focus them too closely on specific technologies because technologies change, but I would focus them on the goals that we want to achieve, and only those goals. So, yes, focus them, but not too narrowly, and let's see if we can use them as a facility of last resort.

Mr. FUQUA. There has been criticism leveled at some of the national labs that they tend to make work for themselves that could be done in other places, perhaps more appropriately in universities. For example, as you mentioned, research relating to growing trees closer together could be done at university forestry schools.

Dr. BUECHE. Mr. Chairman, I think that's human nature. Once you put me in charge of something, I feel that I am honor-bound to maintain its strength, its vitality, its budget and its staff.

Mr. FUQUA. We're familiar with that around Congress. [Laughter.]

And the institution itself.

Dr. BUECHE. And it will take some close looking and the asking of some hard questions to make sure we're getting the biggest "bang for our buck."

Mr. FUQUA. My time has expired, but I will exceed it because we do have to break up in a few moments because of rollcall. You mentioned that programs within 7 years of commercialization must be placed under prime contract or joint management with industry.

How would you know when something is within 7 years of commercialization?

Dr. BUECHE. Well, Mr. Chairman, if one were running a program aimed at commercialization, he should have a program plan. The program plan would say when you intend to have certain elements of work done and when it would be ready for building a pilot plant or some commercialization activity. Seven years is a fairly generous amount of time. I don't stick to that. It could be 5 years for some things, 3 years for others, or 15 for still others, but the program plans, if they're done properly, would tell us when that time would be and what the criteria would be.

Mr. FUQUA. In other countries, what policies do they have for government-industry-university relationships with laboratories?

Dr. BUECHE. Well, it varies country by country. The Soviet Union, for instance, has a large collection of laboratories associated with its major industries, which aren't quite like our major industries. In addition to that, it has some rather large, centrally funded and directed laboratories reporting to the chief scientist of the nation.

The big trouble with that system is that they have a great difficulty in providing the incentives to move the technical work into production and bring it to the benefit of the people.

In Japan, at the other extreme, government laboratories are minimal, and most government objectives are achieved by funding joint industry activities. MITI, for instance, if it sets out to develop a bigger computer—or thinks the country should—involves Hitachi, Nippon Electric, Toshiba, and so forth in doing this, and they form a joint industry program. This seems to work like a charm and they seem to be able to move very rapidly to the marketplace.

Mr. FUQUA. We will stand in recess. We have possibly two votes, back-to-back, so we will stand in recess for approximately 10 or 15 minutes. I apologize for the inconvenience.

Dr. BUECHE. It's completely understandable.

Mr. FUQUA. The committee will stand in recess.

[Recess taken from 10:54 a.m. to 11:25 a.m.]

Mr. FUQUA. The joint hearing will resume.

Dr. Bromley, you mentioned in your testimony, I think, a very significant issue that has concerned me for some time, relating to national labs and the university system, and that's the renewal mechanism or regeneration or maybe "recharging the battery," as it may be referred to.

What is the impact on the national labs if their researchers and scientists are unable to recharge, and how could we go about infusing them with more university faculty and students?

Now Dr. Massey mentioned the infusion at many of the labs and I think some of the other testimony made that point, but this has not been the tendency in some of the older, more entrenched labs. As a matter of fact, it has been suggested that some have not had any new ideas in the last 40 years.

How do we do that to make sure that we keep this renewal mechanism operating?

Dr. BROMLEY. Mr. Chairman, I would have to state at the outset that I don't have an answer for you, but it is a question that has been addressed, I know, by all the laboratories. The thing that really saves us in the universities is the fact that we bring in generation after generation of very bright young people, and there's no question that this really does play a vital role in keeping our laboratories active and regenerated.

One of the problems, is that over the last decade budget limitations have tended to cut into programs that previously worked rather effectively at the national laboratories, where there were rather well-developed fellowship programs which brought young people into the national laboratories for periods of a few years before they moved on to other more permanent employment. This was good for them and it was good for the national laboratories.

Also, there has been, because of the funding limitations, less interaction between some universities and the national labs than there had been in the past and, therefore, less young people coming into the laboratory programs on that basis.

In general, there is no easy answer for most of the laboratories unless there is a major change in personnel policies. If you have what is essentially a limited mission, and you have a number of permanent people, there is very little room left for the amount of interaction with, and throughput of, young people that I know the laboratories' directors and their senior scientists would like to see.

The only partial solution, it seems to me, that will work in the near future is the one that has been suggested several times this morning, namely, that of opening up the laboratories much more to the university community and having much more exchange, because even though the students may be located and anchored back in the universities, their presence in the national laboratories, together with young faculty, can have a very beneficial effect.

Mr. FUQUA. Thank you.

Mrs. Bouquard?

Mrs. BOUQUARD. Thank you very much, Mr. Chairman.

I think you will agree with me that we certainly have a great deal of expertise and a tremendous bank of knowledge before us today, and I want to thank you for sharing with us your thoughts, the benefit of your wisdom, and your years of experience concerning our national labs. It's been very profitable for me.

As a Representative of the Third District of Tennessee, I have been very much impressed with the work being done at Oak Ridge national lab. I am very prejudiced, I'll admit. Dr. Bromley, I certainly appreciate your comments as to what we are trying to do at Oak Ridge.

I know that even in our EBT project that we've not only encouraged industrial participation, but we've gone out of our way to see that they do become more involved than perhaps they would have been had Dr. Postma not openly said "We do want to work with industry. We welcome your commitment." Oak Ridge is not trying to overlap what industry, in fact, can do itself. The lab is working for participation with our universities, but also with industry as well. I think we are making a great deal of progress in this area.

Dr. Keyworth, as we are preparing to move into a technology development phase in the magnetic fusion energy program, does the thought of limiting the national laboratories' role to substantially fusion science research and establishing industry's role as technology development cause you or any of the other witnesses here today a great deal of concern; that the labs would be limited in what they could do?

Dr. KEYWORTH. I would like to begin by introducing a cautionary note. The development phase for fusion energy does not occur as a discontinuity. That means that it is not 1 day later than the research phase.

There continue to be a number of very fundamental research issues in magnetic fusion in which the national laboratories remain, I believe, the optimal institutions to address. And, this is one area where the national laboratories and industry are beginning to work well together. I underline the word "beginning." I believe that the transfer of fusion technology should be encouraged in an orderly fashion by the Department of Energy and that considerable thought will be required to assure that it is done effectively.

But I believe that for many years to come, the national laboratories will be required to maintain a very fundamental research role for magnetic fusion.

Mrs. BOUQUARD. They should not be involved in technology demonstration as we progress in our fusion program?

Dr. KEYWORTH. I would prefer to see industry carry out the demonstration projects.

Mrs. BOUQUARD. I'm talking about the interaction between the labs and industry, working together.

Dr. KEYWORTH. No question. No question. They must work together.

Mrs. BOUQUARD. You feel industry should be the prime contractor.

Dr. KEYWORTH. Yes, I believe that industry should be.

Mrs. BOUQUARD. Dr. Bueche, you say in your testimony that you didn't feel that any further energy centers should be established. I was wondering how you felt about the Center for Fusion Engineering which is an industry lead center?

Dr. BUECHE. Madame Congressman, I wasn't too familiar with that until Bill talked to me during your intermission.

As long as it's just a management function, and as long as the numbers are severely limited—I suggested 12 rather than the 150 that was bandied about during the intermission, and providing it's well-salted with people who have actual practical industrial experience, I think it's a good idea.

Should it grow, however, to 150 or 1,500 as the case may be eventually, and should it establish new facilities, I think it would be a great mistake. I think the management job can be done by 12 or so, very smart people; I think that the existing facilities and groups of people already existing in government and university installations can do the technical work required.

Mrs. BOUQUARD. I think Dr. Bromley, in his testimony, emphasized that he felt that the labs should increase participation of industry as well as universities because we have a greater concen-

tration of facilities in our national laboratories, and it seems to me that your testimony, Dr. Bueche, reflected a different philosophy, that we should increase the role of the university instead of our national laboratories.

Dr. BUECHE. Wherever possible, I think you should, because I think we get an extra something by involving graduate students and sometimes, as Dr. Bromley said, undergraduate students in performing the technical work. It then becomes support for engineering faculty, where engineering faculty are very much undersupported. In fact, I'm told there are over 2,000 tenure-track, engineering faculty vacancies in our universities today. We need to build that up so they can train students. Also the work would provide support for students.

Let me hasten to add, I don't really think that a major facility, let's say something which requires a lot of nuclear safeguards, things of that sort, should be duplicated throughout the country, and there are places, perhaps at Oak Ridge, where a facility already exists that should be utilized and we should find another way of interacting.

Oak Ridge, in the fusion area, has representatives from all the major potential manufacturers onsite, actually helping with the work and I think that's a marvelous way to do it, because there's no sense in duplicating things in universities and industries throughout the country.

It takes some judgment, but to the extent possible, I would push as much of that work out into the universities to help train students or into industry to hasten the commercialization.

Mrs. BOUQUARD. I don't want us to spend too much time on this, but I was thinking of the use of the major facilities. We can't have the same sophisticated facilities at our universities that we have at our national labs. That's the point I was trying to make. It would not be economic.

Dr. BUECHE. It may not be economic and it may distort the prime purpose of the university. Where you need such large major facilities I think are the proper role of Government installations.

Mrs. BOUQUARD. Do you agree with that, Dr. Bromley?

Dr. BROMLEY. I would certainly concur with that, Madame Chairman. Our experience in this country certainly has been such as to suggest that it has been a mistake to build very large facilities in university contexts. Unfortunately, the interaction between the other personnel at that institution and the group working with the large facility tends to become antagonistic; it is not in the best interest, I think, of most universities to have a very large facility in their midst.

Mrs. BOUQUARD. Thank you very much. I again want to commend you for your very fine testimony.

Thank you, Mr. Chairman.

Mr. FUQUA. Thank you, Mrs. Bouquard. Mr. Lujan?

Mr. LUJAN. I would imagine that all of our discussion about lab interaction with universities and industry is primarily in the nondefense area. Is that what we're talking about, or are you gentlemen also talking about the defense area?

Dr. KEYWORTH. I, for one, Mr. Congressman, certainly believe that for Los Alamos National Laboratory and for Livermore, that

the strong university-laboratory interaction that have occurred, particularly at Livermore with the University of California, and at Los Alamos, with the University of New Mexico, have been key to the level of excellence that these labs have demonstrated in their nuclear weapons development responsibilities.

Mr. LUJAN. So there is a lot of interaction in the area of nuclear weapons development?

Dr. KEYWORTH. With the weapons laboratories, there is.

Mr. LUJAN. But is it on the weapons work or on civilian energy work, or basic research?

Dr. KEYWORTH. The people who are actually responsible for designing nuclear weapons occasionally have interaction on basic research interests; but, primarily, it is true that the nonnuclear weapons parts of the weapons laboratories have the strongest university interactions. But mind you, the basic research portions of those laboratories are key to the strength of the nuclear weapons program also.

Dr. BROMLEY. May I add to this, sir, that from the university point of view I have to say, that our system of Federal Government-university interaction is largely a product, as you know, of the early initiatives of the Department of Defense. It has served us well, and, in fact, one of the problems that we face in the university community now is the fact that in recent years this interaction with DOD has tended to erode. I, for one, would very much like to see some of it rebuilt.

I think that there is a very real benefit to be gained, both by the Department of Defense and by the universities, in having our facilities and our students engaged in defense related work, both basic and applied, as long as it's not classified or highly sensitive.

Mr. LUJAN. Because of time limitations, let me pursue the university relationship first of all. As you know, Dr. Keyworth, I'm from New Mexico. As a matter of fact, you happen to be my constituent.

One of the concerns that I've had for a long time is that the University of New Mexico in Albuquerque, which is in close proximity to both Sandia and Los Alamos, is not particularly known for people wanting to go there for an education in the nuclear sciences. That indicates to me that there's not very much interaction between the university and the two laboratories.

My feeling is that, with those two laboratories there, with all that's available to it, the University of New Mexico should be one of the leading schools, and everybody around the country would be clamoring to go there because of the good relationship that could exist with the laboratories and the university.

Dr. KEYWORTH. Mr. Congressman, what I think is building today should have occurred a long time ago. You must remember that, Los Alamos only began expanding beyond its principal weapons mission in 1970. Since that time, I think you will find that the University of New Mexico's interest in nuclear physics, for example, has increased considerably.

The introduction of the Los Alamos meson physics facility strongly influenced this so that now there is quite an active collaborative research program on that facility with the University of New Mexico. So it is beginning. I think it is strengthening the

University of New Mexico in this and in other areas, particularly the physical sciences, and we should look forward to the future.

Mr. LUJAN. I myself would like to mention one good example, particularly in the cancer research that's being done between the university and the laboratory.

Give me other examples and other areas. How are students involved, other than giving them a summer job, that sort of thing? How are they really involved in learning and being of some use to the laboratories?

Dr. KEYWORTH. I will certainly admit that the principal interaction between the University of New Mexico and Los Alamos (and I believe the same thing is true between the University of California and Livermore) has been with faculty and faculty-scientist interactions.

I believe that those laboratories should be encouraged to accommodate graduate student research, not simply through the summer student mechanism that exists today, but through on-site, resident graduate student research.

Mr. LUJAN. I have been focusing just on those two particular laboratories and that particular university, as all of us take a particular experience and then generalize it to say the same situation exists elsewhere.

It's been my feeling all along that there has been minimal interaction between Los Alamos and the University of California. The University of California has a rule about travel that doesn't allow faculty to go back and forth all the time.

Dr. KEYWORTH. Let me give you my own personal opinion, going back to my role as an administrator at Los Alamos. I certainly very, very strongly valued the relationship with the University of California and perceived that any alternative operating mechanism would be inferior.

There are some details with the University of California that have been criticised in the past and there are problems; but, I have certainly not been able to imagine a superior relationship. And in complete agreement with what Dr. Massey said, I think that relationship has strongly contributed to the overall excellence of the laboratory.

Mr. LUJAN. Well, that superior relationship could be "Leave us alone." You know, "Take your fee and let us run our program." That's the way I've perceived it in the past.

I'm not particularly concerned about the contract with the University of California, but it's not as close a relationship as it is for those universities that are close to the laboratories, where there is really a lot of interplay. I really have some grave concerns about that.

Yes, Dr. Bromley?

Dr. BROMLEY. May I say, sir, that to give a somewhat broader geographic spectrum——

Mr. LUJAN. I'd like to do that. I'd like to get it away from this particular case.

Dr. BROMLEY. From our university on the east coast, we have maintained, since the opening of the Los Alamos Meson physics facility, an in-house group; Yale employees, Yale researchers, who have remained at Los Alamos, who are using that facility actively,

are doing it today, and we have been very much pleased by the effectiveness of that cooperation. It really is being used by a national university constituency.

Mr. LUJAN. They are Yale employees that use the facility?

Dr. BROMLEY. They are Yale employees, Yale graduate students, Yale post-docs, Yale faculty, working in collaboration with Los Alamos staff and with staff from other universities, doing very effective research.

Mr. LUJAN. Is that the same thing at Argonne? Just to take it away from home.

Dr. MASSEY. Each laboratory is different and the degree to which their programs allow them to interact with universities varies, but I think if one looked in detail, you'd find a lot more cooperation than apparently one is aware of.

Mr. LUJAN. Maybe it's just not apparent to us civilians.

Dr. MASSEY. I guess not.

Mr. LUJAN. Thank you, Mr. Chairman. I'm sorry, Dr. Bueche?

Dr. BUECHE. Congressman, I would like to comment that if all the appropriate programs were transferred to the universities, then it would be up to the people in the Government labs to travel to the universities to get this information. This would build up, in your case, the University of New Mexico, and at the same time, establish this industry-Government-university interaction that you seem to be seeking.

Mr. LUJAN. Thank you.

Mr. FUQUA. Thank you. Mr. Skeen?

Mr. SKEEN. Thank you, Mr. Chairman, and I want to express my appreciation to the panel. I thought the material covered today was very interesting and very appropriate.

Dr. Keyworth, there is one question I'd like to ask. In an issue of The Economist on June 20, you have a statement in there that:

> The United States has over 30 national laboratories financed by the Government but run by universities, companies, or nonprofit institutions. The largest, Sandia Laboratory, spends more money than goes into the R. & D. budgets of Harvard, MIT and Stanford combined. Nobody doubts the work at Sandia is impressive, but in a tight financial climate, is it really worth more than the research done in three of America's finest universities?

I wondered, Doctor, did that include the weaponry work that's done at Sandia, or was this just straight civilian R. & D. that could be handled by universities?

Dr. KEYWORTH. Mr. Congressman, that particular article in The Economist I found extremely interesting and filled with more editorializing than is even common. I'm not sure what lay behind that because they were not primarily my words.

Mr. SKEEN. Thank you. Well, it was upsetting to me because I know that you know what the budgetary split-ups are and what is unique, and I think Dr. Bromley pointed this out in his testimony that some of these laboratories have unique work, such as Sandia, in the area of weapons development and associated R. & D. work.

I was just curious. I'm not being argumentative about it. I just wanted to give you a chance to respond.

Dr. KEYWORTH. The point that I was trying to make in that article, and I do not believe it was entirely reflected, was simply that we are spending an enormous amount of money in the national laboratories. And, at a time when we are undergoing such tight

budget scrutiny in the universities, I believe it irresponsible not to examine the national laboratories with equal perspicacity.

Mr. SKEEN. I can go along with that and I do appreciate it, Dr. Keyworth. I do want to say too that I congratulate you on your position and, as a fellow New Mexican, I'm proud that you're here. Thank you very much.

I thank the rest of you. Very good testimony.

Dr. KEYWORTH. Thank you, Mr. Congressman.

Mr. FUQUA. Mr. McGrath?

Mr. MCGRATH. Thank you, Mr. Chairman.

At the outset, Dr. Keyworth, may I, too, extend to you my best wishes in your new endeavor.

Mr. Chairman, I want to congratulate you. Last week we had a hearing in the Space Science Subcommittee where we had panelists who were bright, articulate and had different and diverse opinions on various issues, and today, we also have bright and articulate spokesmen for their particular interests. I always like to have panels where you don't have handcuffs on nor do you beat each other over the head.

I was interested, Dr. Keyworth, in your testimony on page 5. There was a paragraph that said:

> It is important to bring out into the open and discuss more fully the matter of equitable policies regarding such matters as contract awards and accountability.

And it says:

> Here we are dealing with the criticism over the alleged privileged status of the national labs in terms of their not being subject to the same type of review that industry contracts or university grants receive.

You ought to know where I'm coming from first. I'm from Long Island, and I am wondering whether or not you had in mind the ISABELLE program at Brookhaven when you were referring to that.

Dr. KEYWORTH. Certainly not. I approached that objectively.

Mr. MCGRATH. Thank you.

Dr. KEYWORTH. But there are examples throughout all the national laboratories that would apply to that, and many that are better examples than the ISABELLE project.

Mr. MCGRATH. I have no further questions, Mr. Chairman.

Mr. FUQUA. Mr. Lowery?

Mr. LOWERY. Thank you, Mr. Chairman.

Dr. Keyworth, I, too, wish to welcome you to Washington. I'm glad that you're here and I look forward to working with you in the weeks ahead.

I'm sorry I missed the earlier testimony. I was tied up on the floor, but I'm curious as to what role you see the administration taking with the national labs. Will it be rather similar, as it has been in the past, where the center of concentration has been with the nuclear program, or will the national labs serve more as managers, if you will, with more diverse responsibilities toward the research that's taking place largely through the campuses and through industry?

Dr. KEYWORTH. I certainly consider that the national laboratories' primary mission will continue to be research. In terms of other roles, the administration has not completely analyzed the options for the national laboratories. I would emphasize, however,

that I believe that the national laboratories should play a catalyst role among Government, industry, and academia.

Mr. LOWERY. More so than they have in the past?

Dr. KEYWORTH. More so than they have in the past.

I also believe that some of their missions are, let me say simply, outdated, and I believe that both for the laboratories' own benefit and for the country's, those missions should be reexamined. But I wish to emphasize that I believe the administration's perception of the national laboratories is one that is under scrutiny.

Mr. LOWERY. Do you see major expansions or contractions in their activities, and how would that fare with some of the budget constraints?

Dr. KEYWORTH. I think the probability of major expansion is slim. On the other hand, I think it premature to address the question of major reduction.

Mr. LOWERY. So you envision that we're going to get more bang for our buck with the existing budget that we now have.

Dr. KEYWORTH. I think it can be achieved with some ease, because I do not believe that the Department of Energy has examined the national laboratories with any scrutiny since its inception.

Mr. LOWERY. When do you expect your reviews will be completed? The reviews of the administration?

Dr. KEYWORTH. We have not begun yet, and it was only suggested today that we might formally undertake such a review. However, let me say that, without the formal request by the Department of Energy, I would anticipate that it would occur logically within the normal fiscal year 1983 budget cycle.

Mr. LOWERY. OK. Thank you.

Thank you very much, Mr. Chairman.

Mr. FUQUA. Thank you very much. I want to thank you, Dr. Keyworth, for your being here today. I think it suggests that a review of the role and scope of our national labs certainly is in order. I think there's been some very good testimony today.

I think there have been expressed some very constructive ideas about how we may be able to improve and better utilize our national labs in light of the fact that new funding constraints have evolved.

Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman.

First, I want to congratulate you and the chairman of the other energy subcommittee for pulling this very fine and talented group of witnesses together as a panel, and I want to apologize to them for being in and out of the meeting all morning.

I would like to ask Dr. Keyworth, if I could, if he believes that the labs' share of energy R. & D. funding is appropriate at the present time in relation to funding provided to the universities and industry.

It might have been asked. If this has asked before, let me know. I didn't hear it.

Dr. KEYWORTH. No, quite so specifically.

I believe that that fraction is too large. I believe that the national laboratories represented the simplest mechanism for the Department of Energy to use to pursue its earliest initiatives. I think we and the Department of Energy should look very carefully as to the

means for transferring some of that research into industry and academia.

Mr. WINN. Our committee obviously is quite concerned about coming to grips with Federal spending in the future, and since you're pretty new aboard, I'll throw this one at you and see what your opinion is and if you think that inflation is a science policy issue.

Dr. KEYWORTH. It certainly perturbs science policy, but I'm not sure that I would say inflation itself is a science policy issue.

Mr. WINN. Let me broaden it a little bit, then.

Is the Government, in your opinion, coming to grips with the real economic issues that relate to technology? That might clarify it.

Dr. KEYWORTH. I think we are trying. We are a young administration. I think we are examining our policy in this area. It is evolving.

Mr. WINN. How are you doing that? How are you approaching that? What systems are you using?

Dr. KEYWORTH. Several straightforward mechanisms. Of course, one of them is to examine, as has been phrased, the "bang for the buck." Another one is to examine the relative priorities of our objectives. Another one is, of course, and that's what we're discussing today, to examine our institutions.

Mr. WINN. I got into a pretty good hassle in the last couple of weeks with people from the National Science Foundation. Not a hassle. I'm just trying to get them to take their pro rata share of the cuts that I think everybody's going to have to take in this country. For some reason or another, they didn't seem to agree with that, and I sort of caught a lot of flack from the science community.

We brought it to a vote and my amendment was defeated. I'm not a sore loser, I just wonder why it is that perhaps the science community doesn't feel that they ought to be a part of this nationwide trend that will unfold probably yet today.

Dr. KEYWORTH. Mr. Congressman, I think this is a key point and I think I agree with the trend of the question entirely.

I believe that the scientific community cannot be excluded in the issues of the administration's economic recovery. In other words, the scientific community is going to have to take its cuts and it is going to have to help us make those cuts in an effective fashion.

I think the issue of the National Science Foundation was a very complicated one because of the very high visibility of some of the elements in the overall program.

I personally strongly believe that this country can conduct a stronger research and development effort than is currently being done, even with less dollars than we are currently spending. I think many of our activities have, let's say, not aged in an efficient fashion, and I think that is one of the statements that some of us are trying to make today.

Mr. WINN. Thank you very much.

Mr. Chairman, I may have some additional questions. I would like to have the opportunity to submit some of those to these distinguished gentlemen in writing if I may, and add those to the record.

Mr. FUQUA. Thank you.

Yes. There may be some questions in writing that we may want to submit to you, and we would appreciate your response in addition to the ones that Mr. Winn has requested.

Again, I want to thank all of you for being here today. Dr. Bromley, Dr. Bueche and Dr. Massey, we appreciate very much your contributions, and I think we have had a very constructive hearing this morning on issues that we all are interested and concerned about. Our primary concern is that we maintain a strong research and development base in this country, that we get our technology into commercialization, and that we train the scientists to continue to do the great work that they have for this country, the American people, and people all over the world for many years.

Thank you very much.

Mr. SKEEN. Mr. Chairman?

Mr. FUQUA. Mr. Skeen?

Mr. SKEEN. Excuse me for interrupting, but before we leave, I'd like to issue an invitation to this committee, and we've done it for one other subcommittee, from Senator Schmidt and myself who are cosponsors for the Showcase for Technology that will occur in Albuquerque in October. It's an important step in the national laboratory, university and industry effort for cooperation in commercial innovation.

Dr. Keyworth is one of the speakers at that particular showcase, so we issue the invitation.

Mr. FUQUA. Thank you. I hope some of us can attend.

Mr. SKEEN. Thank you, sir.

Mr. WINN. All expenses paid? [Laughter.]

Mr. FUQUA. Thank you very much, and the hearing is adjourned.

[Whereupon, at 11:56 a.m., the hearing adjourned.]

[Questions and answers submitted for the record follow:]

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ARTHUR M. BUECHE
SENIOR VICE PRESIDENT

August 31, 1981

The Honorable Marilyn L. Bouquard, Chairman
Subcommittee on Energy Research
and Production
Committee on Science and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, DC 20515

Dear Madam Chairman:

Enclosed are my responses to your questions on National Laboratory Relationships with Industry and the University Community. I hope my thoughts will be of some help to you and the Committee in evaluating the programs and policies under your authorization responsibility.

Sincerely,

A. M. Bueche

AMB/bmo

Encl.

QUESTIONS FOR DR. A. M. BUECHE
FOR HEARING ON
"DOE NATIONAL LABORATORY RELATIONSHIPS
WITH INDUSTRY & THE UNIVERSITY COMMUNITY"

Q.(1) From your perspective as a manager of an industrial R&D organization;

a. Have the DOE multi-program laboratories adequately diversified their energy R&D activities relative to their former mission under the old Atomic Energy Commission?

A. As I stated in my testimony, it is my view that the laboratories have diversified beyond the point that can be justified on grounds of efficiency or effectiveness. The following table shows that many of the 12 multiprogram laboratories are involved in most of the DOE Energy R&D activities which were not a part of their AEC missions. The extent of overlap and apparent unnecessary duplication is especially overwhelming in light of the very large number of additional DOE facilities now devoted to these programs.

DOE R&D Program Areas	Number of Multiprogram Laboratories	Number of Other DOE R&D Facilities
Basic Energy Sciences	10	6
Biomass	3	1
Elec. Energy Systems & Storage	8	0
Environment	12	20
Geothermal	7	0
Hydropower	2	0
Magnetic Fusion	10	2
Solar Applications	8	3
Solar Technology	9	3
Conservation	8	1
Coal	11	4
Gas	3	2
Petroleum	6	3

Source: DOE/ER-0029, Appendix F, June 1979

b. Do the DOE labs carry out sufficient R&D on a variety of alternative energy systems?

A. I believe the variety may be more than sufficient. A question which should be addressed is whether the R&D on all the present energy systems on which the laboratories are working is appropriate to the role of these in-house facilities.

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Q.(2) Is it fair to say that a strong DOE laboratory system would be essential in the event we undertake highly complex "crash" programs (say, for national security reasons) or could presently available industry laboratories fill this role?

A. A "crash" program likely would have as its objective the creation of energy supplies to offset the impact of interrupted oil imports. Such a program would involve the immediate displacement of oil utilization wherever possible (e.g., in electricity generation and space heating) so that our transportation system and other critical liquid fuel applications could be supplied. The technology, production and delivery systems for the necessary actions exist in industry and the DOE laboratories would not have a significant role.

To develop more economic supply capacity that would be desired if the oil supply interruption were expected to be drawn out over a period of years, it would be necessary to build new production facilities as quickly as possible. Again, the approach would have to be to use existing technology and the necessary engineering and construction capability is in industry.

Q.(3) The DOE national labs have established so-called "national user facilities" for basic research, which are open to university and industry researchers alike.

Should DOE also establish corresponding user facilities for technology development purposes?

A. My statement for the Hearing included the recommendation that existing DOE facilities be made available to private industry and universities on a reimbursable and proprietary basis when the work is deemed to be in the national interest. Guidelines for such use should be developed by the OSTP review board which I recommended.

Q.(4) What can the DOE laboratories do to foster university-industry collaborations?

A. Where the laboratories manage DOE exploratory research contracts, joint industry/university proposals could be encouraged (as has been done by the NSF). The granting of ownership of patents developed under government sponsorship would be in some cases a useful incentive for industry participation in such joint projects.

Joint proprietary users of laboratory resources might be allowed to reimburse the laboratory only for its "out-of-pocket" costs (i.e., unburdened direct labor and materials) rather than full-cost recovery.

Ownership rights to previously developed laboratory inventions might be offered to joint ventures that would make the investment necessary to commercialize a new technology. Such ownership could be granted to the winners of a competitive proposal process.

Q.(5) On page 5 of your testimony you referred to the technology transfer difficulty and suggested eliminating it by placing more work in private labs. Have you looked into the extent to which the government labs subcontract to industry or let grants to universities? Aren't these significant ways of assuring technology transfer without having to deal with institutional barrier to transferring the results of strictly in-house work to industry? Please comment.

A. I understand that the laboratories have, over the years, subcontracted a portion of their DOE-supported energy research to industry and universities. This does, of course, help to reduce the barriers to technology transfer, but it is not an appropriate solution to the transfer problem created by the present tendency toward overuse of in-house facilities. In the first place, assignment of a program to a national laboratory with the direction that a certain portion be subcontracted can be, in a practical sense, nothing more than a way of augmenting the Federal staff. Secondly, national laboratories have a conflict of interest with regard to subcontracting; i.e., there is a strong incentive to retain work in-house if it is needed to provide for maintaining a healthy organization.

Since the national objective is to create and expedite the commercialization of energy technology through private industry, it would be advisable to shift the balance toward more contracting with the private sector. Then, if there are unique and essential facilities or competences in the national laboratories, the private contractor should be free to subcontract appropriate portions as he and DOE see fit.

Q.(6) On page 6 you refer to the fact "that there may be a considerable amount of duplication and overlap in the twelve multi-program laboratories..." What is the quantitative basis

for this observation? Isn't a certain amount of duplication among laboratories healthy for R&D programs? For example, the Committee is convinced that the Livermore-Los Alamos competition has been very beneficial to the DOE. Please comment.

A. The table herein presented in response to your first question indicates, for example, that DOE's 1978 R&D on solar energy was scattered over 23 in-house facilities, and 32 of its facilities were performing environmental research.

Competition among research teams can be useful, especially where timing is more critical than the availability of funds, but these data suggest the possibility of a lack of proper program focus rather than a carefully planned interlaboratory competition.

Q.(7) On page 7 you refer to a "decline in the real dollar R&D budget of DOE" and then you note that the non-weapons staff fell by only one-tenth of the real budget reduction. Might not some of this discrepancy be explained on the basis that research and technology base-activity may be increased while specific project activity involving major contracts and fewer in-house people was reduced? Please comment.

A. Your argument to support the maintenance of a constant level of in-house staff in the face of a cutback in total funds between 1980 and 1981 may be sustainable, but one might more simply observe that it is a continuation of the longer-term trend that I mentioned. Since 1978, DOE's constant dollar budget for energy and general sciences R&D dropped by 12% while the non-weapons-related staff of the multiprogram laboratories grew from 34,000 to 36,000. In addition, the industry share of Federal energy R&D fell from 64% in 1974 to 38% in 1979.

Q.(8) What is your opinion on the benefits of the national labs managing university grants and industrial contracts which complement their own in-house efforts? Isn't this an ideal way to assure that technology transfer occurs?

A. Please see my response to your question number 5.

Management of grants and contracts by the laboratories is not ideal. It may be appropriate in some instances, but the emphasis should be on placing all possible work directly in the universities and industry.

Collaboration and transfer could be facilitated by private contractors subcontracting to the laboratories and by the establishment of jointly managed programs under DOE coordination. It must be remembered that the private sector is the ultimate user and customer for energy technology and therefore has the greater stake in the achievement of technically and economically feasible results.

Q.(9) On page 8 you talk about the lack of "natural incentives for constant purging of unpromising efforts." Isn't the budget process involving the executive and legislative branches and incorporating industrial perspectives on in-house efforts an effective mechanism for weeding out projects that apparently have no commercial appeal? Please comment.

A. The budget process of the Federal Government works as well as could be expected for allocating resources among programs aimed at providing the services that are the essential role of government. However, if we hope to gain the efficiencies of the market system and private entrepreneurship in supplying our energy needs, we must remember that the "natural" incentives for technological innovation are in the private sector. As I stated in my testimony, the DOE does not have the mission of supplying energy in our economy, is not the principal customer for energy technology, does not provide a market for leading edge technologies, as was true for NASA and DOD, and thus has no direct stake in the economic performance of the technology which it pays to have developed.

Q.(10) On page 10 you suggest that the DOE adopt certain policies including dropping all commercially oriented programs that don't have significant industry or university involvement. At what phase of the R&D cycle would you apply such criteria? Are you suggesting that the labs do no basic research unless it is with the university and no applied research or exploratory development unless it subcontracts to industry? How can you nail down just when a program is "within seven years of commercialization?" Would you suggest joint industry management even if the federal cost-sharing on a project exceeds 50%?

A. My statement suggests the phase-out of commercially-oriented technology development programs that do not have significant industry or university involvement. I am primarily concerned that work that has a more or less near-term commercialization objective be moved toward closer ties to those who will create the products and deliver them to the market place. I also

suggest that there are laboratory programs that warrant direct involvement of universities and industry, transfer to prime contracts with industry or universities, or cancellation. I have not said that all laboratory programs fall into one of these categories.

It is customary in joint ventures that authority is varied in some relationship to the equity participation of the partners. Participants contributing less than 50% may have a significant role in management even though they do not have final authority in case of disagreement.

Q.(11) Why not simply have the Secretary of Energy set up a separate industry-university review board to rate DOE lab programs rather than going outside to the Office of Science and Technology Policy. Is your proposal on this point based on a skepticism or distrust of the Energy Research Advisory Board's ability to review and rate these programs?

A. I believe the Secretary and the nation will benefit by taking advantage of the unique qualifications of Dr. Keyworth for this undertaking. Furthermore, the proposed approach would avoid the stigma of having this rather sensitive task established and coordinated by in-house staff.

Q.(12) Do you agree with Secretary of Energy Edwards' statement before the House Science and Technology Committee that "the readiness of the Magnetic Fusion Energy program to enter the technology development phase is not in question"? If you don't agree, what data has the Energy Research Advisory Board, the Science and Technology Committee's Fusion Advisory Panel, and the International Atomic Energy Agency overlooked? If you do agree that we should begin to move into the technology phase, would you subscribe to the belief that this phase should be centered in Industry, not in the national laboratories? Would not an industrially managed, Center for Fusion Engineering, help to expedite this process?

A. I am encouraged by the confidence expressed by many fusion experts that scientific feasibility of fusion will soon be demonstrated. It would appear that the first steps toward engineering experimentation and the development of industrial capability should be taken so that economic feasibility can begin to be addressed.

Over time, the focus of the fusion program should be transferred from the national laboratories to industry, and industry and the utilities must be positioned to determine the requirements for demonstrating economic feasibility. Once there is adequate experimental information on which to determine the optimal engineering approach, the laboratory

effort level can be reduced and the proposed new Center for Fusion Engineering (CFE) could be appropriate.

As a step in this transition, GE has recommended that the original plan for the Fusion Engineering Design Center at Oak Ridge should be fully funded and executed. Several industrial firms, including GE, are a part of a transitional program which was aimed at developing the conceptual design and baseline cost estimates for the Fusion Engineering Device, the focal point for the CFE.

Plans should be prepared, during this interim period, for transferring the management of fusion technology development to the CFE and for moving key development programs into industry. I see no justification for leap-frogging these transitional steps and moving, perhaps prematurely, into the development of a Center for Fusion Engineering.

8/31/81

U.S. Department of Energy
ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439
Telephone 312/972-5555

August 18, 1981

The Honorable Don Fuqua
House of Representatives
Washington, D.C.

Dear Mr. Fuqua:

During the hearings on July 29, you asked a question about the regional mission of the national laboratories. A year ago, in our institutional plan for FY 1981-1986, we addressed this matter as follows:

> ...Argonne desires to work with DOE to better define regional R&D roles for each of the multipurpose national laboratories. We recognize that the energy resources, energy demand, technological options, environmental problems, and regulatory approach are regionally sensitive. Indigenous factors such as the regional economic structure, fuel and mineral resource availability, utility system characteristics, political structure, etc., all affect the technical and economic feasibility of alternative energy systems. The solution of the national energy problem will depend on strong regional components, and some of the technologies utilized in the Southeast may be minor contributors to the solution of the problems in the Midwest. DOE and the national laboratories should work together toward defining how the laboratories might be more effectively used on a regional basis.

More specifically, you may be interested in knowing of some activities just starting in the Chicago metropolitan area. Mayor Jane M. Byrne has announced formation of a Taskforce on High Technology Development to link area universities, industries, and research and development centers. The Taskforce, which I have been asked to chair, will serve as a subcommittee to the Chicago Economic Development Commission and will include "top scientists, professors and business leaders who will pool their experiences, ideas and wisdom...", according to the Mayor.

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

A similar statewide effort is under consideration by Governor Thompson, with state and University of Illinois officials discussing establishment of a research center at Champaign-Urbana. It is expected that the state and city programs will complement each other, not compete.

The enclosed clippings from the Chicago papers will provide more detail on these efforts, which are just getting underway.

Sincerely,

Walter E. Massey
Director

MLP:vmk
Enclosure
cc: R. H. Bauer
A. Joseph
H. Gray
L. Nosanow
C. H. Percy
E. Czadowski

Sun-Times
Thursday, August 6, 1981 Page 57 Editorials

An independent newspaper, dedicated to championing individual freedom, to exposing abuse of the public trust, and to fostering a healthy environment, a sound economy and a just society.

Using brains to win jobs

A few weeks ago physicist Walter E. Massey, director of Argonne National Laboratory, used our Personal View column to challenge public officials.

The Chicago area's "best-kept secret," he wrote, is its superb collection of academic, scientific and industrial research centers. Why not use this brain power to forge a plan for economic growth?

Mayor Byrne read that, agreed and acted.

Massey is now head of her new Task Force on High-Technology Development. This team of top scientists, professors and business leaders will develop strategies for luring high tech industries to Chicago, lobby for federal research projects and lay the groundwork for combination research-and-exhibition centers in fields where this area excels. (We can think of at least two: medical science and heavy industry.)

A similar coordinated effort by government, business and academic institutions started the New England industrial revival in the mid-1970s. We should have started years ago, too. As William T. Ylvisaker, chairman of Gould Inc., wrote in another recent Personal View column, "The Chicago area can provide an intellectual climate that can offset the sunnier climes of the South and West. But this will come only as the research activities of private companies in the area and those of academia generate a community of scientists cooperating with each other."

Byrne announced formation of her task force at another overdue event: a workshop sponsored by the Illinois congressional delegation and the Chicago Association of Commerce and Industry to help businesses apply for federal contracts.

Illinois has been notoriously shortchanged for years in all types of federal spending. One example: This state gets less than three-tenths of 1 percent of defense research and development contracts, despite its rich resources.

Byrne has established a new federal procurement division in the city Purchasing Department to identify products that have federal markets and to help Chicago businesses bid for them. Gov. Thompson should do the same at the state level.

Chicago Tribune XC ALD's

FOUNDED June 10, 1847

4 Section 2

Sunday, August 9, 1981

The politics of Chicago's growth

The political leaders of the city and state are beginning to recognize their central role in the economic competition with other states and regions. Mayor Byrne has appointed a high-powered group of scientists and businessmen to explore ways to attract high-technology industry to the city. And the state congressional delegation in Washington is beginning to work together in search of ways to direct more federal contracts toward Illinois.

The mayor's new committee, led by Walter E. Massey, director of the Argonne National Laboratory, has a tough job. High technology industry needs secure building space and a resourceful labor force; it has shied away from northern industrial inner cities in the past. But there must be ways to build new business upon Chicago's strong institutions of higher education and its important scientific and medical community.

The mayor has also created an office to help Chicago businessmen through the labyrinth of bidding for federal contracts. With the support of a congressional delegation that is not only willing to work together but also has enormous influence in the present Congress, this can be a productive enterprise.

Political leaders simply must get involved, deeply involved, in promoting the economic growth of the city and state. Not only are there still serious general governmental problems — the city schools, transit, crime, laws that dissuade businesses from locating here — that must be overcome. But there is also a big selling job to do, and political leaders have the contacts and resources to do the job.

Instead of bemoaning Illinois' small share of federal contracts, the congressional delegation can reverse the situation. Instead of complaining about the migration of business to the sunbelt, political leaders can take steps to counteract it.

The economic decline of the industrial northeast, including Illinois, has been natural but not inevitable. And the new initiatives by Mayor Byrne and the Illinois congressional delegation show that they are not willing to surrender.

Inhuman relations

The Chicago Commission on Human Relations, an organization to promote compassion and understanding, couldn't seem to find it in its heart to provide one of its handicapped workers a washroom she could use. It wasn't much for the worker, Carlos Clarke, to ask. But more than a year of asking was ignored. She had to pull herself down the street in a wheelchair to get to a washroom she could use. And people at the commission even criticized her for taking too long.

Tribune columnist Anne Keegan went into the details of this example of bureaucratic callousness, and on Friday the commission finally announced that it would provide washroom facilities for the handicapped. If this is the way city government promotes human sensitivity, you wonder whether it won't next sponsor a contest for the best blind joke.

CHICAGO TRIBUNE
August 9, 1981

City, state vying for high-tech companies

By Charles Storch

IN THREE WEEKS, state officials are scheduled to begin a campaign to lure fast-growing high-technology companies to Illinois. Last week, Mayor Byrne announced a similar, separate campaign to attract such firms to Chicago.

Both campaigns will tout their area's scientific, educational, industrial, and financial resources. Both will hold out the prospect of establishing a major research facility, either in Chicago or on the University of Illinois campus in Champaign-Urbana.

And both will face heavy competition from other areas of the country, equally intent on landing scientifically advanced firms that generate jobs and federal contracts.

But the campaigns may find their biggest obstacles at home, some people say, in the politicians, universities, scientists, and financial institutions that have kept high-tech business development here a low priority for years.

THE STATE Department of Commerce and Community Affairs will begin Aug. 30 a multimillion-dollar promotional campaign to attract industry, especially high-technology companies, to Illinois. Peter Fox, the department's deputy director, said the high-tech effort will be directed initially at microelectronic and computer firms, but may expand to firms in the telecommunications and genetic engineering fields.

The scientific, industrial, labor, energy, and financial resources in the state will be extolled in magazine inserts, television commercials, and direct mailings. State officials also will make direct sales pitches to some 60 companies considered likely to relocate or expand in the coming years.

Fox said state and University of Illinois officials have been discussing establishing a research center in Chicago or Champaign-Urbana. Such a center, he said, could be a magnet for top scientific talent and industry, and could be modeled after Research Triangle Park in North Carolina or a research park at New York's Gensselaer Polytechnic Institute.

At RPI, the university provided 1,500 acres and worked with several firms to establish a microelectronics center, Fox said.

ESTABLISHING A Chicago research park is one of the proposals to be studied by Mayor Byrne's new Task Force on High Technology Development.

The task force, comprising local scientists, academicians, and business executives, also will consider special high-tech development zones for the city and increased lobbying efforts for government contracts. One of its roles will be "to ballyhoo (Chicago-area research and development) assets to private industry around the country," the mayor said.

A little ballyhoo wouldn't bother Leon Lederman, director of Fermi National Accelerator Laboratory in Batavia. "Science and technology in this area is one of the best kept secrets in the United States," he said.

Illinois would seem to have impressive high-tech credentials. With Fermilab and Argonne National Laboratory, the Chicago area has two major government-owned nuclear research centers. Illinois is no longer the leading state in the electronics industry (a position relinquished to California), but still is home for many large electronics firms and firms in many other advanced scientific fields.

THERE ARE MAJOR industrial research centers such as those of Bell Laboratories and Standard Oil Co. (Indiana) on the East-West Tollway near Fermilab. There are significant research facilities at the University of Chicago, University of Illinois, Northwestern University, and Illinois Institute of Technology and its affiliated IIT Research Institute.

And Chicago is a major center of banking and venture capital. Much of the money, however, is flowing to finance fledgling high-tech firms (some started by university faculty) in California, Massachusetts, Texas, North Carolina, and Georgia.

Lederman believes that if this area's scientific achievements and resources were better advertised, more world-class scientists and more high tech-firms would be drawn or start up here. He has been working with people at Argonne and the University of Chicago to develop a nationally telecast science show, which he hopes could do as much for this area's research as "Nova" has done for the scientific community in the Boston-Cambridge, Mass., area.

He also would like to broadcast to the state's congressional delegation that Illinois needs more government contracts, especially the defense and space contracts now saturating Sun Belt states.

"WE DON'T HAVE A dedicated congressional interest in what we in the scientific community here are doing," Lederman said.

E. F. Heizer Jr. agrees. As head of the nation's largest independent venture capital firm, Chicago-based Heizer Corp., he has seen high-tech firms and venture capital seed money follow defense dollars wherever they land. And they have been landing in piles in other parts of the country, but not in Illinois.

"We don't have any representatives really interested in science and research and development," he said. "And when the defense budget grows, our big local companies get all excited about making gears for tanks. They don't get excited about the more advanced areas of work."

Nor do some of the area's major universities, some scientists say. They claim the University of Chicago, for example, puts too much emphasis on theoretical rather than applied research.

THE UNIVERSITIES HERE have been criticized for not aggressively trying to spin off their research to business, especially when government funds are drying up. Although institutions here have some licensing arrangements with firms and some are considering joint ventures, the local schools haven't yet come close to matching the activity of Harvard University, Massachusetts Institute of Technology, and Stanford University.

Critics say the universities here don't try to promote entrepreneurship — the dream of starting one's own business — among their faculty, while universities elsewhere demand it.

In some scientific departments at MIT, it is said, an understood requirement for tenure is a demonstrated ability to start a business and to become a millionaire. In contrast, IIT, a local joke goes, is content to provide the sergeants of industry.

"We have some good talent in the Midwest, but the people here don't necessarily have the drive to start firms or to want to spin off their ideas. I don't sense the drive you see in people on the West Coast," said David Morrison, president of IIT Research institute and a member of the city's high-tech task force.

ANOTHER TASK FORCE member, Richard Ivins, agrees. "We just have a conservative role model in the Midwest. People go to school here to get a job in a big company, not to spin off new businesses," said Ivins, director of industrial marketing sciences at Argonne.

Unfortunately, said James Howell, financial institutions in the Midwest "are as conservative as they are in the Confederacy."

Howell, chief economist at the First National Bank of Boston, said banks and insurance companies in New England have been very aggressive in financing new, high-tech firms.

HOWELL BELIEVES Illinois won't be able to compete with some Sun Belt states for high-tech firms — not because of Illinois' poor climate but because of the prevailing high labor wages and extent of unionization.

Argonne' Ivins recognizes the difficulties ahead but is optimistic. "I think it will be a challenge to the business and political communities to make something here, to create an environment for the entrepreneur," he said. "But there's no reason why we can't do it."

Byrne forms panel in drive to lure high-technology firms

By Charles Storch

MAYOR BYRNE on Tuesday announced a three-part program aimed at luring high-technology companies to Chicago and garnering federal contracts for local small businesses.

Saying that the "race for federal dollars and high technology industries is too lucrative (for Chicago) to sit out," Mrs. Byrne announced that the city is forming a task force to study such proposals as using city-owned land for a research park and designating special zones for high-technology companies.

In addition, the city will establish a federal procurement division in its Purchasing Department and will sponsor a meeting between a delegation of local small businessmen and federal officials in Washington, the mayor said.

The announcement of the mayor's program came just a few weeks before the state Department of Commerce and Community Affairs is scheduled to unveil its own campaign to attract high-technology firms to Illinois. The promotional effort will be aimed at companies in such fast-growing fields as computers, electronics, telecommunications, and biogenetics, said Peter Fox, the department's deputy director.

FOX SAID he expects the state and city programs to complement each other, not compete. A press aide to the mayor said he hadn't heard about the state's program, but Fox insisted that city officials have been informed of the details.

The Task Force on High Technology Development will be a subcommittee of the city's Economic Development Commission and will include top Chicago area scientists, professors, and business leaders, Mrs. Byrne said in a luncheon speech at the Illinois Federal Procurment Conference at the Conrad Hilton Hotel.

This "nonpaid brain trust" will be chaired by Walter E. Massey, director of the Argonne National Laboratory, a spokesman for the mayor said.

Mrs. Byrne said the group will study tactics used by other cities to attract high-technology companies, including assembling city-owned land for a research park, designating special high-technology zones, intensifying lobbying for government-financed research and development, and sponsoring recruiting visits to companies considering relocating.

THE NEW FEDERAL procurement division will help local small businesses submit proposals and bids for government contracts, the mayor said.

To further assist local small businessmen, the city will sponsor a meeting in Washington later this year between federal procurement officials and a delegation of Chicago businessmen. "If this trip is successful, we'll plan more for 1982," said Mrs. Byrne.

Joining Massey on the mayor's task force will be Richard O. Ivins, director of industrial marketing sciences at Argonne; Dr. David L. Morrison, president of the Illinois Institute of Technology Research Institute; Dean Bruno Boley, professor of civil engineering at Northwestern University; James Hartnett, director of the Energy Resources Center of the University of Illinois Chicago Circle Campus; and James Arnold, the city's purchasing director.

The mayor said she soon will announce the remaining task force appointments.

Chicago Tribune
8/5/81

Chicago Sun-Times, Thursday, July 23, 1981

Needed: a partnership of research, business

Personal view/William T. Ylvisaker

THE PERSONAL VIEW by Walter E. Massey, director of Argonne National Laboratory, has opened a much-needed dialogue about the efforts required to assure a continuing healthy economy for the Chicago area.

Too often, I believe, we continue to look at industries that made Chicago strong in the past rather than those that can help build its future. For example, the stockyards and meatpacking industry moved west in response to economic pressures and more efficient methods of slaughtering and marketing. But at the same time, the area around O'Hare Airport was becoming a second downtown to Chicago; it's now a conference center for all America.

WILLIAM T. YLVISAKER

If the Chicago area is to continue to attract new businesses, the concentration of research facilities that Massey referred to must play a key role. We are moving into an era when advanced technology will determine what products are useful and the most efficient means by which they can be made. Contact with our local research centers can assure corporate managements that their thinking and strategic planning is keeping pace with the electronics revolution changing the face of American industry.

MASSEY CALLED FOR a partnership of federal, academic and private research agencies. It's important to remember that each has a distinctly separate role to play.

Federally funded research will be increasingly directed to defense requirements. Academic research will continue to be directed toward pure science and theoretical pursuits. But the closer the contact between these two research activities and the private sector, the easier and quicker will be the application of new findings to applied technology and the new products and processes such technology makes possible.

Direct federal funding for private research is certain to be reduced. This calls not for protests to Washington, but for more imaginative application of our own resources. Often it will be more economical for a corporation to fund academic research in related areas than to establish its own laboratories.

In recent years we've seen a decrease in the percentage of our gross national product spent on research. We still have not regained the levels of the late 1960s, when the door to our present computer-dominated era was just swinging open.

In this respect, one of the most important provisions of President Reagan's tax bill is the proposed tax credit equal to 25 percent of the incremental wages paid directly for "R&D"—research and development. This would permit us to match in at least one respect the encouragement the Japanese government gives to its businesses through a tax credit equal to 20 percent of any year-to-year increase in R&D spending.

Note that this credit is for *incremental* wages only, and could be used only if the company increases its R&D spending. The proposed law also assures that the credit is available only to companies with an established income flow to generate such credits; it thus would prevent abuse by blue-sky tax shelters.

AS A CHICAGO-BASED multinational company, we at Gould believe the Chicago area can provide an intellectual climate that can offset the sunnier climes of the South and West. But this will come only as the research activities of private companies in the area and those of academia generate a community of scientists cooperating with each other.

Two years ago Gould formed a scientific advisory board to act as a senior research policy-making body for our company. Board members are all distinguished specialists in science, engineering and technology. In quarterly meetings with top Gould officials, they are able to examine and discuss concepts that go far beyond their technical consultations.

THIS COOPERATIVE EFFORT between scientists and the corporate world is increasing. And, as Massey wrote in his Personal View, there are few areas of the United States that can draw on the extensive resources in university and research laboratories that we have here in the Midwest. Facilities at Argonne National Laboratory and Fermi National Accelerator Laboratory, as well as those at Northwestern University, the Illinois Institute of Technology, the University of Chicago and the University of Illinois at Chicago Circle attract scientists from throughout the world.

Scientists such as Walter Massey rightfully see new resources for research in such partnerships. Equally important to Chicago business leaders is the fact that new products in this age of technology come from new ideas. It is from this partnership of research and business that the Chicago industries of the future will grow.

William T. Ylvisaker is chairman and chief executive officer of Gould, Inc., a multinational company with headquarters in Rolling Meadows—and, he adds, a company that has more than doubled its research expenditures in the last five years to its present $115 million a year.

From Chicago Sun-Times
July 7, 1981

Chicago area must use its secret weapon—R&D

Personal view

Walter E. Massey

IT IS an uncomfortable truth of history that needed changes are most apt to come from times of stress, when people are forced to try new ideas. During "good times," the status quo is more apt to seem adequate.

WALTER E. MASSEY

Some planners suggest that the Chicago area is now in a period of economic stress, and that this is not a short-term phenomenon but the culmination of a continuing, long-term trend. They argue that the nation's resources in the future will be directed to the Sun Belt instead of historical centers of industry like the Chicago area. This is partly because heavy manufacturing and its feeder industries, traditionally the basis of our economy, have been hardest hit by the present economic cycle. And the Sun Belt states and those with relatively new, high-technology industries have been least affected.

WHETHER THESE prophecies turn out to be true will depend on what is done in Chicago by Chicagoans. We can timidly accept this economic planning philosophy that dooms our future growth or we can muster the resources of this area in new ways to forge our own future.

A first step in this new direction is to recognize and exploit the Chicago area's best-kept secret: This is a major national center for "R&D"—research and development—and it has potential for even greater future growth.

Chicago already has three foundations for growth in research and development: a strong industrial base, the intellectual vitality of a strong college and university infrastructure and internationally recognized, publicly funded laboratories.

About $13 billion a year for R&D is invested in Illinois by private corporations, ranking us seventh in the nation for such activities. Most of this investment occurs in the Chicago area.

THIS ACTIVITY IS conducted at numerous facilities, including Bell Laboratories, American Can, Borg Warner, Standard Oil Amoco Research Center, International Harvestar, Arco, Armac and Western Electric, to mention only a few. Also, private research centers such as the Institute for Gas Technology and Portland Cement Association make significant contributions.

This industrial strength is complemented by schools like the University of Chicago, Northwestern, Illinois Institute of Technology, the University of Illinois at Chicago Circle and a complex of smaller colleges and technical institutions. These supply the intellectual talent for industry as well as contribute to the research base.

FURTHER, THIS AREA has two internationally known, federally funded centers of research: Argonne National Laboratory and Fermi National Accelerator Laboratory. Historically their missions have included cooperation with industry and academia. The Reagan administration has emphasized the role of national laboratories in conducting advanced research with potential for high payback, turning results over to private industry once the risk and investment parameters have been determined.

Cooperative research between Gould Industries and Argonne National Laboratory on advanced technical batteries is an example of this kind of interaction.

Argonne is now engaged in research on superconducting transistors, more efficient ways to use coal, more efficient fuel cells, improvement in environmental safety for a variety of energy sources, solar energy, early detection of disease through cataloging of protein elements in human cells and advanced work on nuclear fusion and fission.

THE POTENTIAL OF such research to benefit the local industry and economy is proven. For example, Illinois' lead in safe, cheaper electrical energy can be traced to pioneer work at the University of Chicago and to Argonne to unlock the secret of the atom and atomic generation of electricity.

But to meet this area's need for more jobs and more industry, better coordination is needed between federal, academic and private research agencies. These three sources of research also have a mutual self-interest in increased cooperation. However, coordination of research and development activities is not, by itself, enough to meet Chicago's economic needs. The R&D effort must be part of a broader strategy for the area's industrial and commercial development.

IT IS A NEED that can be met only by mustering the best minds in the Chicago area to analyze and plan our economic future. That kind of over-all direction with solid support from the general community can refute prophets who see growth only in the Sun Belt.

As director of Argonne National Laboratory, I can say that we stand ready to cooperate in such an effort. As one familiar with the R&D programs of local industry and the universities, I know that an almost infinite potential is ready to be tapped in the local scientific and technical community.

Walter E. Massey is director of Argonne National Laboratory and physics professor at the University of Chicago.